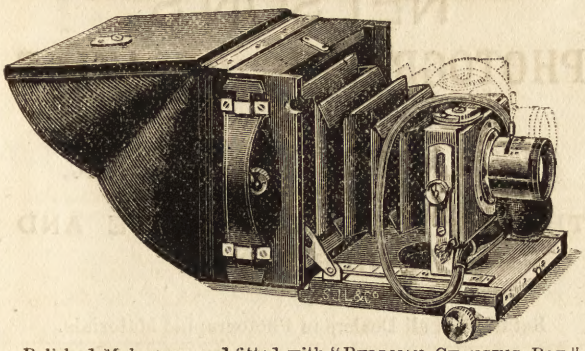
POCKET "MINIA" CAMERA.



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½-plate, to carry 8 Plates or 12 Films ..	21/6	26/6
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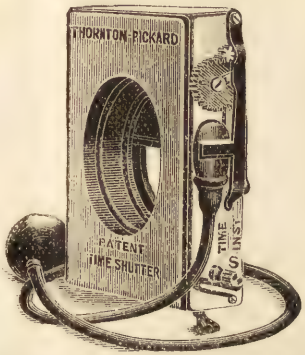

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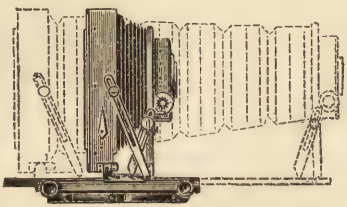

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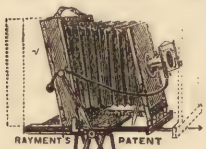

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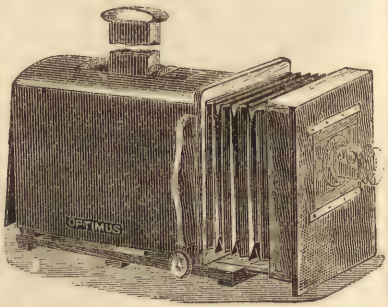

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A SHORT GUIDE TO THE PRACTICE OF ALL THE USUAL PHOTOGRAPHIC PROCESSES FOR PROFESSIONALS AND AMATEURS

BY DR. E. VOGEL

Assistant in the Photo-Chemical Laboratory of the Royal Technical High School at Berlin

TRANSLATED BY E. C. CONRAD, F.C.S.

From the Second German Edition

With many Illustrations and a Copious Index

THIRD  EDITION

LONDON

SWAN SONNENSCHEIN & CO., LTD.

NEW YORK: MACMILLAN & CO., LTD.

1896

PREFACE TO FIRST EDITION.

We have already numerous large and small books on photography. This guide owes its existence to the desire of many amateurs and students of the Royal Technical High School to possess, in a small compass, an account of all the important photographic processes.

The author has sought to present these in the greatest completeness and the smallest space possible, having regard to the needs of the beginner as well as to those of the practical photographer and the amateur. Copying processes, which are ignored in most of the smaller books on photography, are included.

With regard to the recipes given, especial care has been taken to give only good, practically-tested formulas. It is very difficult for beginners in the photographic art to choose the most useful of the innumerable formulas published for developers, collodion, intensifiers, etc., and therefore the selection given here, which is limited to those in use in the Photo-Chemical Laboratory of the Royal Technical High School, will be welcome to many.

The Author.

Berlin, *August* 1891

PREFACE TO SECOND EDITION.

From the quick sale of the first edition of the "Pocket-book" the author believes that he may infer it to have answered in some measure the requirements of such a short guide.

In the second edition the recent additions to the province of photography have been noticed where they are of *practical value.*

May the "Pocket-book" make many friends in this new edition.

The Author.

Berlin, *June* 1892.

PREFACE TO TRANSLATION.

DR. VOGEL is so well known in the photographic world that any book bearing his name is sure to receive attention.

In presenting the following translation to the English reading public my endeavour has been to follow the author as closely as the idioms of the respective languages will permit, and I hope and believe that this little book will prove largely useful to every section of the photographic public.

THE TRANSLATOR.

GRAVESEND, 1892.

INTRODUCTION BY THE TRANSLATOR.

DR. VOGEL, having written his book in German for the use of Germans, has naturally given the names of manufacturers established in that country as supplying the apparatus mentioned by him; but as there are manufacturers in England and America whose productions are excellent, it is unnecessary for readers to apply to any but their ordinary dealers. For the information of those who are making a start in photography, I would say read the instructions on the different kinds of apparatus given in this book, and then go to any respectable dealer and inspect the various productions of different makers stocked by him, say how much you wish to spend, and decide on the size you intend using.

The usual sizes are: quarter-plate, $4\frac{1}{2} \times 3\frac{1}{2}$ in.; half-plate, $6\frac{1}{2} \times 4\frac{3}{4}$ in., $7\frac{1}{2} \times 5$ in.; and whole-plate, $8\frac{1}{2} \times 6\frac{1}{2}$ in. Of these either of the first two sizes are quite large enough to commence with.

The apparatus required consists of a camera; dark slides or double backs to hold two plates, three is a convenient number; a stand that is compact when

closed, and rigid when open; a lens—an ordinary view-lens will do for a commencement, and can be got for a few shillings, but a corrected lens is better. Then for the dark room a ruby lantern is the first requisite; three dishes for development, etc.—the most convenient are those made of some unbreakable material, and that can be easily rocked; a drying or draining rack is useful, but not absolutely necessary; two or three printing frames, and some bottles to hold solutions and chemicals will complete the outfit.

Do not buy too large an outfit to commence with for if after a time a larger size should be worked a fresh set would probably be required. Test all the various portions before purchase, according to the directions given in the following pages.

I give below the names of a few makers whose productions I have had the opportunity of using; but in order to avoid any invidiousness, I beg to state that without doubt there are numbers of makers and dealers who supply materials in every way as good as those mentioned.

For cheap sets the productions of Messrs. Lancaster, of Birmingham, which are stocked by all dealers, are good and serviceable, and at the price marvels of value. Messrs. W. Watson & Sons, of Holborn, supply cameras, double backs, and stands, more especially, that in material and workmanship are excellent, and in use will be found as good as can be desired; they are of course higher in price. Messrs. Perken, Son, & Rayment, of Hatton Garden, supply lenses of all descriptions. With regard to plates, I have used all that can be said to be before the public, and although

I have my individual likes and dislikes, I am unable to say that any one make is so much better than the others as to merit exclusive mention. I would say to the beginner, use one brand until you can make a satisfactory negative, and then try the others, and make a decision. Hand cameras are now very popular, and for those who wish to work a small size present advantages in compactness and portability that outweigh their defects. Before buying one of these it is important to give it a thorough trial, as some on the market are defective either in the lens, shutter, or changing arrangements.

Referring to the various formula I have, when possible, given the proportions in "parts," and where that could not be done I have given the weights and measures (*viz.*, grammes = grms., or cubic centimetres = c.c.), as in the original, together with their approximate equivalents in grains = grs., or fluid ounces = ozs., or in minims when the amount represented fractions of the oz. Readers who wish to be quite exact can use the metric system of weights and measures given in the first column; while those who perfer it can use those in the second column; there will be no difference practically.

CONTENTS.

THE

PHOTOGRAPHIC POCKET-BOOK.

INTRODUCTION.

PHOTOGRAPHY is the art of producing images on light-sensitive surfaces by means of the chemical action of light.

This picture-making can take place in two ways :—

(1) By *printing processes.* Take a piece of the sensitive silver-paper, which can be obtained commercially, lay flat leaves and grasses upon it, and a plate of glass over all; then the leaves protect the paper from the action of the light, which turns all the uncovered parts brown. But by a longer exposure the light also penetrates the half-transparent parts of the leaves, so as to mark out their veins; thus there is obtained a very fine copy of the leaves, in which the darkest (opaque) part appears clear and the most transparent dark, so as to make it an inversion of nature; such a light picture is called a *Negative* (Fig. 2).

Drawings can be copied or printed in equally simple ways; these printing processes are extensively used in building and engineering offices, generally on blue paper.

(2) By forming an optical image by means of

highly sensitive plates, whose sensitiveness is 20,000 times greater than that of silver-paper; this takes place in an apparatus which is called a camera, a

FIG. 1.

FIG. 2.

word meaning chamber, because the first images of this kind were produced in a room.

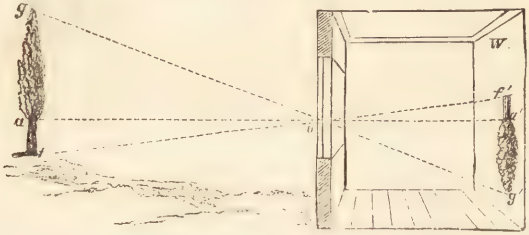

FIG. 3.

For the production of such images a hole in the window shutter of a darkened room is alone necessary.

Fig. 3 shows how such an image is formed, *a* being a poplar tree, *o* the hole, *w* the back wall of the

room. Now suppose rays of light proceed from each point in the poplar tree through the hole, and arrange themselves in straight lines, growing farther and farther apart as they approach the wall. It is clear that light from the point *a* on the poplar tree can arrive at the

FIG. 4.

point *a'* in the room only if *o* lies in the direction of the line *a*.

Therefore the corresponding point on the wall can only reflect light which in colour and position resembles the point *a*. The same thing holds good for the points *f'* and *g'*, and consequently the result is that an inverted image of the tree is visible on the wall.

The above apparatus was soon so far improved

that instead of the room a small box was taken, which had a flat movable screen in place of the fixed wall. Upon this screen the image of any object can be distinctly seen if a pin-hole is made in the front of the box, and turned towards it

These pictures look better if a glass lens is put in

Fig. 5.

the place of the hole. The lens forms at the distance of its focus a distinct image of an object, which is much sharper and clearer than that produced by a pin-hole. For this reason lenses are always used in photographic apparatus, although photographs have been taken with pin-hole cameras.

If now a sensitive plate is placed in the place of the mage projected by a lens or through a hole, it will

change most at the clearest parts of the image, less so at the duller parts, and will remain unchanged at the darkest parts. It will consequently become a perfect copy of the image.

But the pictures obtained by the modern processes by the *exposure* of the highly sensitive plate are invisible until by means of the following process, that of *Development*, which plays the principal part in photography, they become visible, and appear as *Negatives* (see Fig. 4).

From these negatives positive pictures are prepared by means of printing processes (Fig. 5).

An unlimited number of positives can in this way be obtained from a single negative.

The number of methods of preparing negatives is comparatively small, while the number of ways of dealing with positives is great in proportion. To the last division belong also the photo-mechanical processes, such as the methods of preparing plates for block-printing, lithography and copper-plate engraving by the help of photography.

1.

PHOTOGRAPHIC APPARATUS

1. Photographic Cameras.

The camera is one of the simplest optical instruments. It consists of a symmetrical bellows (Fig. 6), the front part of which turned towards the object bears the *objective o*, and the back, opposite this, consists of a

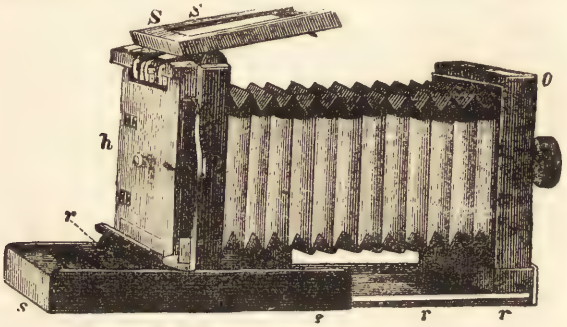

Fig. 6.

flat screen *SS*, which can be more or less approached to the objective, and when turned back can be replaced by a little flat case *h*, called a *dark slide*, which holds the sensitive plate.

The intervening box or bellows serves only to produce a dark chamber. That this is perfectly dark

is a condition which is a *sine quâ non*. To test this in a newly bought camera, throw a black cloth over the head, and place it in the apparatus (having inserted the objective and lifted up the screen), and look for crevices admitting light.

The principal part of the camera is the objective; that is to say, a lens, or system of lenses, which throws upon the focussing screen what is called an optical image (see p. 2) of any object in front of the camera. This image is only sharp at a very limited range of distance of the screen from the objective, which distance is dependent upon the focal length of the lens as well as the distance of the object; in all other positions it is more or less blurred or "out of focus."

In order to make the image sharp the hind part of the camera, with the focussing screen, can be more or less approached to the objective. This is usually done by means of a toothed bar with a milled head or screw.

The nearer the object to be taken is to the apparatus the larger it will appear, and the greater also will the distance be between the objective and the screen.

The screw *r* serves to make all firm when the position is found in which the inner part of the image is sharp. If the part *h* is very near the objective the long base-board *ss* prevents the observation from going on, and so renders the control of the image on the screen difficult. Therefore in many apparatus the front part *r* of the camera is movable, the screen-bearing part being fixed instead.

By adjustment the view can only be focussed as far as the middle of the image is concerned; the sharpness of the edge is obtained by putting in a stop (see further under "Objective"). The smaller the stop the sharper will the image be, but also the longer will be the time of exposure. Always focus without a stop, or with the largest if it is com-

bined with the objective, as in Revolving or Iris diaphragms.

If all appears correct the screen *SS* is turned back (Fig. 6), and the dark slide, with the sensitive plate, put in its place.

In all cameras the arrangement must be so contrived that the sensitive plate takes up the *exact* position of the focussing screen, otherwise the image will not be sharp. In order to prove whether the camera is properly constructed in this respect, focus a fixed object upon the screen, making use of a positive eye-piece such as can be bought at any photographic optician's; then take away the

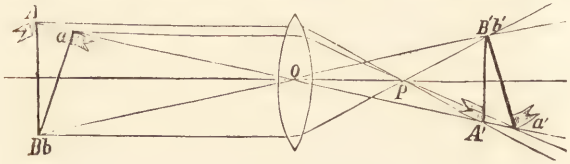

FIG. 7.

screen, and slide in the dark slide, putting in the latter a piece of ground glass instead of the sensitive plate, and look whether the sharpness of the image is still the same. If not, the dark slide is not in register.

Sometimes the focussing screen can be revolved about its horizontal and vertical axis; this contrivance is of value in focussing objects which have a position oblique to the axis of the instrument, as that of the flag *ab* (Fig. 7).

This forms an oblique image *a' b'*, which could not be made sharp with an upright screen, but would be all right with an inclined one. Similar objects are a sitting man, etc.

The arrangement of the dark slide is evident from

Fig. 8. The sensitive plate is placed in the space B, so as to rest upon the corners of silver wire or glass * *dd*, then the back lid D is shut down and fastened by clips.

In this way the spring *f* presses against the plate, and holds it fast in its place. The slide H, moving through a slit, remains shut, and is only opened when the dark slide is in the camera and all is ready for the exposure.

For use the camera is placed upon a firm base called a *stand*, which is furnished with castors for moving backwards and forwards, as well as an arrangement

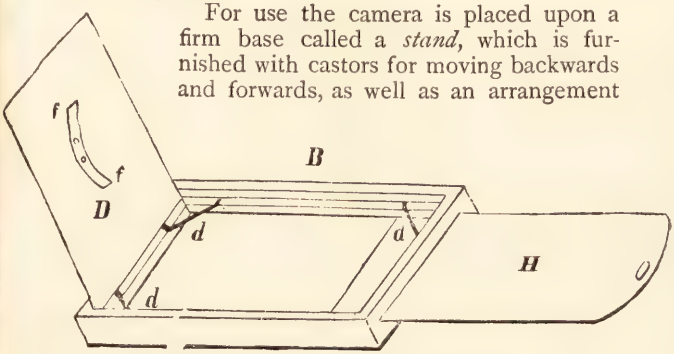

Fig. 8.

for raising and lowering. Fig. 9 shows a good stand.

The camera is placed upon the board B. The pillar A, which carries the board B, can be raised or lowered by turning the handle K. By means of the screw *r* the board B can be sloped so that the camera can take up a position parallel to obliquely situated objects.

* For wet collodion plates corners of silver wire are preferable, as slight impurities collect upon the broad surface of glass. Care should be taken that the glass or silver wire supports are not too large, as otherwise they would render much of the plate useless.

The camera here described is called a *Studio Apparatus*. The speciality of such apparatus is

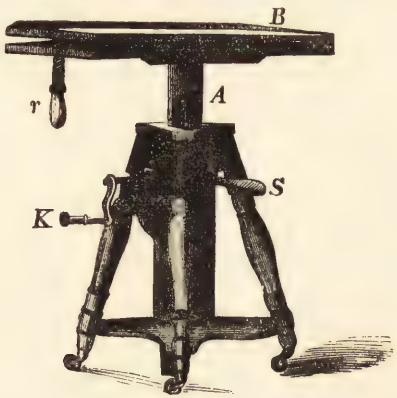

FIG. 9.

solid construction rather than lightness. For work outside the studio, such as landscape, architecture,

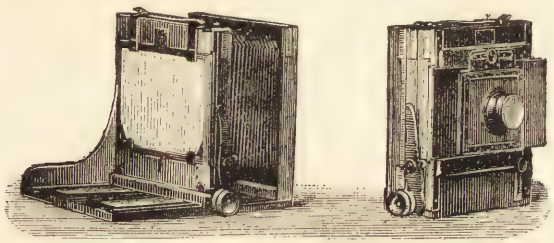

FIG. 10.

etc., a folding apparatus of small bulk is needed, for greater convenience of transport on account of lightness; such are called *Landscape Apparatus* or

Tourist Cameras. They have always a much shorter extension of bellows than studio cameras. For amateurs, who often have need to take drawings, etc., with their landscape apparatus, a provision of a means of extension recommends itself. Such a one is a light removable board, which is fastened in the middle to the base of the camera by means of a screw.

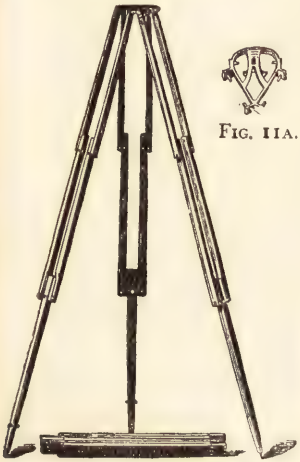

FIG. 11.

FIG. 11A.

Tourist cameras must be made very solidly, yet with the utmost saving of weight. The description of the numerous different constructions would pass far beyond the range of this book. Fig. 10 shows a camera of the most ap-

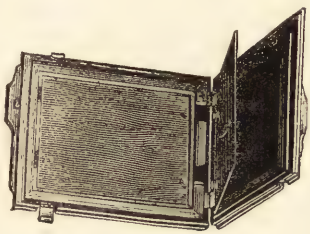

FIG. 12.

proved construction, such as made by Stegemann of Berlin.

Fig. 11 shows a folding stand to correspond. It is arranged to fold together; each foot is held fast in a metal triangle by springs (Fig. 11A). Sliding stands are somewhat less reliable, because they often fail if the wood swells in damp weather. If it is desired to use a landscape apparatus for work in a room or on smooth ground, the stand requires to be additionally secured

by a stand-fastener, a metal band with which the feet of the stand are fastened together, so that it is not possible for them to slide apart. In the absence of such a stand the legs may be secured by a cord.

Double dark slides are always used for landscape cameras. These are shut together like a book, and a plate is put in each side with the sensitive surface down. Dark slides which do not open, and in which the plates are put through the slide with the surface uppermost, are unsatisfactory. It is absolutely necessary for dark slides to be perfectly light-tight (badly made dark slides with flaps that fold back often allow light to penetrate through the hinge). A dark slide can be tested whether it is light-tight by exposing it when containing plates to the sunlight for some minutes, and then developing the plates. These should show no trace of the action of light. Plates which have remained too long in a new dark slide often fog in consequence of the evaporation from the wood through the polish. In this case the slides should be left open when not in use until they lose all smell.

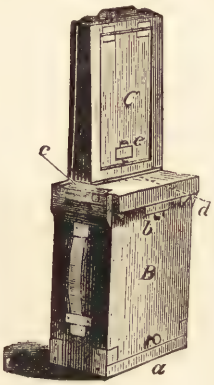

FIG. 13.

In out-door work as well as in focussing the apparatus should be covered with an opaque black cloth for greater security. A well-made apparatus should be so perfectly light-tight that it can stand use in full sunlight without this precaution.

In the place of many dark slides a *changing-box* may be provided, including changing dark slides.

Fig. 13 shows such a one. The plates, usually from 12 to 24, are placed in the box B when the closed

lid *a* is opened. They rest in grooves, which prevent their touching each other. The upper part of the box is made to slide, and has a slit as well as a guide for the insertion of the dark slide C. When this is put in the slit opens automatically, so that the interior of the slide is in connection with that of the box. Then on turning it over the plate slides out of the changing box into the dark slide. This is shut by means of the bolt *e*, and taken out of the slit. After the exposure the plate is returned to the box in a similar way. On again using the upper part of the box is pushed a little farther, so that the next plate is transferred to the dark slide. At *c* there is a register, which records how many plates have been exposed.

In changing care must be taken that the plates slide into the dark slide or box on the glass side, not on the film, which might be scratched; also they must be so put into the box that the films will turn towards the sliding piece of the dark slide.

Dark slides for films. In recent times flexible films of celluloid, collodion, or gelatine have been largely used in place of glass plates. These are called "films," and if they are thick enough can be put like glass in ordinary dark slides, in which a little piece of wood or a glass plate, covered with black paper to avoid reflection, is placed behind, so that the film lies flat, and is not bent by the spring. But magazine dark slides are also constructed which hold a larger number of films, up to 100. These are very valuable for travelling, as frequent changing of plates is often attended with difficulty, and should be avoided.

The arrangement and use of a good magazine dark slide, such as is made by Schreiner of Berlin, is figured below.

The dark slide has a front piece similar to those of an ordinary pattern (Fig. 14), with divisions behind a glass lid *g*, against which the sensitive film is pressed.

The arrangement for holding it there, which is especially represented, seen from behind in Fig. 15, consists of a lid D, which can be bent back if the movable lever lying behind it is straight. Into this place the film can easily be put so that it lies against the glass plate, then when the lever is pulled down it pushes against the lid D, and this presses the film against the glass plate *g*.

The changing of an exposed film is done thus: Open the flap K (Fig. 14) (which closes the maga-

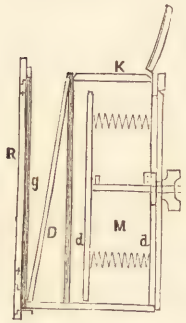

Fig. 14.

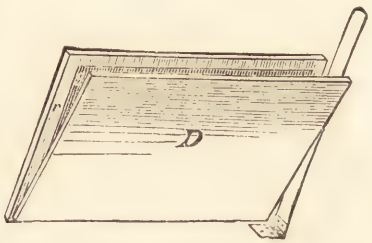

Fig. 15.

zine M in the back part of the dark slide, and which is secured by a protrusion in the middle), take the exposed film with the fingers and place it in the fore-part of the divided space M by the reserve-screen (Fig. 14); then take one of the unexposed films which lie behind the reserve-screen, and place it against the glass *g*.

This takes place within the light-tight bag fastened to the dark slide (see Fig. 16), and is done by the right hand, so that the necessary changes can be made in open daylight without loss of time; but the flap *K* must be shut before the hand is withdrawn

from the changing-bag. The magazine is filled by opening the back *d* (Fig. 14). The cleaning of the glass screen *g* is important. For this purpose the front edge R is drawn from under the narrow piece of metal, and the screen allowed to fall out after raising up the lever, and polished on both sides with soft leather; then the films are fully exposed. The necessity of polishing can be demonstrated by pulling up the screen of the dark slide.

The back wall *d* is double, and fitted with an arrangement which holds the films under a continual

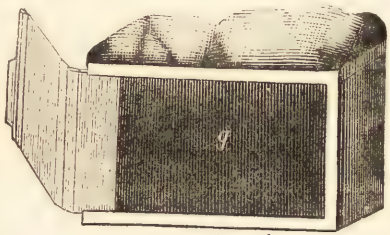

FIG. 16.

slight pressure, which preserves them from damp air and renders the work of changing easy.

The saving of weight by the use of a magazine dark slide is very great. Two double dark slides (5 × 7 in.) with 4 glass plates weigh from 2 lbs. to $2\frac{1}{4}$ lbs.; a magazine with 50 Perntz'schen films weighs about the same.

Stegemann also makes a very useful changing dark slide. Fig. 17 shows this open, with contents exposed. The dark slide consists of a flat wooden box A, with an opened flap-lid D, in the adjoining figure. B is the shutter of the dark slide. The sensitive films G are placed between two ebonite plates of equal size E, F. For the exposure one of these films is brought in front of the ebonite plate

F, so that the sensitive surface is turned to the shutter (that is, downwards in the figure), and the lid D shut. By turning the screw C the arrangement is applied by which the film inside the dark slide is pressed against the glass screen H. (situated behind the shutter) through which it is exposed.

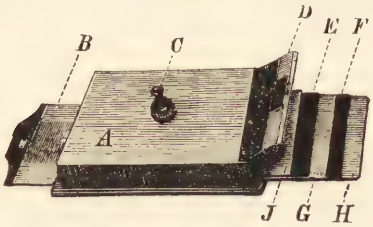

Fig. 17.

If the exposed film is to be exchanged for a new one the screw C is turned, then the lid D opened, and the film placed behind the ebonite plate E. Then a new film is brought from the stock at G in front of the ebonite plate F, and so on until the whole stock between E and F is used. Re-charging must of course take place in the dark. For this

Fig. 18.

purpose the dark slide is thrust into a sleeve of rubber cloth fastened to the wrist.

Even more convenient than the magazine dark slide is the Roll-holder (see Fig. 18), the best one being made by the Eastman Company. The sensitive film has in this the form of a long band wound

round a wooden roller E. The end of the film is fastened to the roller A.

By means of the rollers B, C, and D a piece of the strip is stretched tight for the exposure. If the roller A is turned the exposed film is rolled up, and a new piece comes in its place. An alarm-apparatus shows when a large enough piece is unrolled. A brake-apparatus is attached to the roller to hinder it from unwinding automatically. These roll-holders are adapted for from 50 to 100 exposures, and therefore hold enough material for an entire journey.

In the purchase of apparatus beware of too cheap an outfit, which will want continual repairs, and will finally cost more than a dearer but better made one. Moreover, observe these rules.

1. The apparatus should be made of good wood all through alike, without knots. The larger pieces, such as the shutters of the dark slides, should have the different pieces of wood, which are put together, cut opposite ways to prevent warping.

2. The apparatus must be so made that when it is shut up the focussing screen is protected. In many forms of construction, especially the English, this lies outside, which is very inconvenient, as it is easily broken in conveyance.

3. The lens board must be vertically and horizontally movable, and capable of fixing in any desired position by a screw. If the board is raised the picture has less foreground; if lowered it has more.

4. The focussing screen must be made so as to be folded up, and fastened by a screw (see p. 7).

5. The apparatus must be so arranged that horizontal as well as vertical pictures can be taken with it.

6. The extension of the apparatus must bear a just relation to different objectives. Many forms of apparatus do not slide in sufficiently to be used with an objective of very short focus (a wide angle).

7. The shutters of the dark slides must be made to fold back, or else when used in open-air work the wind often catches them and shakes the apparatus.

8. The stand and camera must not be made too heavy, and yet possess sufficient rigidity not to shake in windy weather.

9. For the transport of travelling apparatus a leather or sail-cloth bag is needed, with straps to hang by. The straps should be as broad as possible, as narrow ones cut, and are painful to carry. For longer journeys solidly made iron-bound chests can be purchased, specially made for the purpose.

2. Photographic Optics.*

General review of photographic objectives.

By objectives we understand all combinations of lenses that are capable of giving an optical image. Fig. 7, p. 8, shows how this is effected or formed.

This optical image is best seen when the lens is screwed into a camera and the focussing screen drawn out for the observation of the image. For this purpose the screen must be made movable (see preceding section).

A good, correct lens, such as one which shows straight lines as straight, is of the utmost importance in obtaining faultless results.

A distinction is made between what are called landscape objectives, which consist of one achromatic lens only, and double objectives, which are made up of two or more lenses.

Landscape lenses reproduce straight lines straight in the middle of the picture, but curve them at the

* In this short guide only a very general review of this, the most difficult subject in photography, can be attempted. For a special study of it see "Shroeder's Phot. Optics"; H. W. Vogel, "Handbook of Photography," Pt. 3.

edge, so they should not be used for taking drawings, architecture, etc., where a correct representation of the original is essential. If you take the square A (see Fig. 19), with a landscape lens and stop in front of it, the picture of it, B, will not appear as a square, but with curved sides like a barrel. The lines are curved outwards. Landscape lenses have also the fault of not being aplanatic; that is, the image can only be made sharp by the use of a stop, while aplanatic double objectives give images sharp in the middle without it.

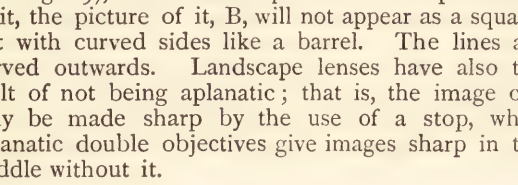

Fig. 19.

There are also double objectives which are not aplanatic, and act like landscape lenses (spherica lenses, pantoscopes), and yet are free from distortion.

In lenses the special points of difference are, in the first place, the diameter of the lens or the stop (see below) and the focal length; that is, the distance behind the lens at which an image of a very distant object is formed. But this distance is not measured from the back of the lens, but from a fixed point called the principal point.

The aperture and focus are of the greatest influence in the brightness of the image which the objective forms. This is decreased in proportion to the square of the focal length; it thus sinks to one fourth in doubling the focus, and to one ninth with the trebling of the

focal length, etc., and the brightness also varies with the square of the aperture.

The size of the image, that is, of the object in the picture, is proportional to the focal length.

By doubling the focal length the object n the picture will appear double size; multiplying by three makes the object treble size. The extension of the camera, that is, the distance from the lens where the image is formed, also depends on the focal length.

All objects whose distance is from 100 *times the focal*

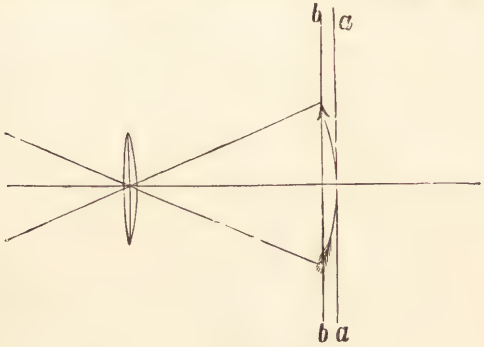

FIG. 20.

length up to infinity appear sharp all over it the focussing screen is placed at the focus of the lens.

Thus an objective of 7 in. focal length will make all parts of objects more than 18 yards away equally sharp. For a lens of 4 in. this distance is 10 yards.

If an objective is used with full aperture, without a stop, it can easily be observed that only the middle part is sharp (in good objectives a space the diameter of which is equal to one third the focal length). This is because the image is not really flat, but curved so that the screen really shows only the

middle point, with which it is in immediate contact,

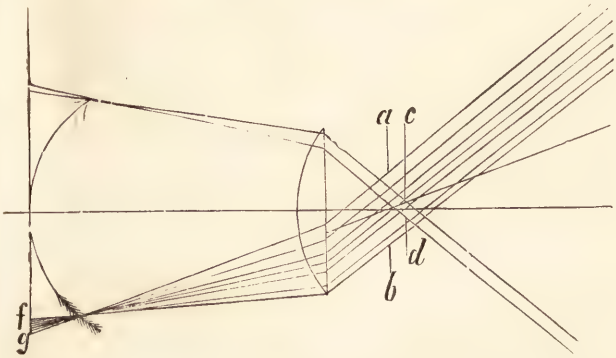

FIG. 21.

quite sharp. If you put the screen at *aa* (Fig. 20) the middle is sharp; if at *bb* the edge only is sharp, the middle blurred.

This blurring of the edge can only be avoided by means of a stop. From the wide stop *ab* (Fig. 21) comes a broadly divergent beam *fg*, while the narrow stop *cd* gives one of small divergence (on the other side of the figure). Therefore stops are absolutely necessary for producing an image sharp right up to the edge.

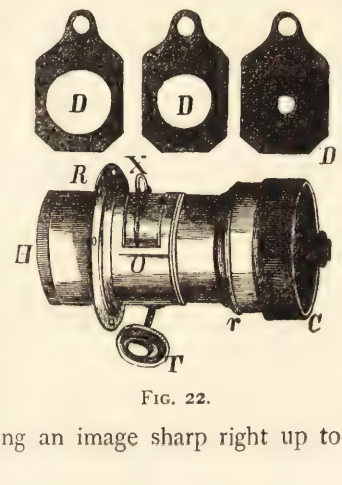

FIG. 22.

But unfortunately this diminishes the amount of light, so that in instantaneous work (portraiture, etc.) sharpness at the edge is given up (by using a large stop) in order to work more quickly.

Stops are blackened plates of metal (see Fig. 22), which have an opening in the middle. They are placed in a slit made in the objective for that purpose, situated between the lenses in double objectives and in front of a single lens.

It is often necessary to use *Wheel* or *Revolving* stops (see Fig. 23), which consist of movable rings

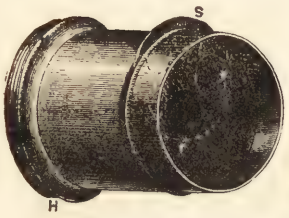

FIG. 23.

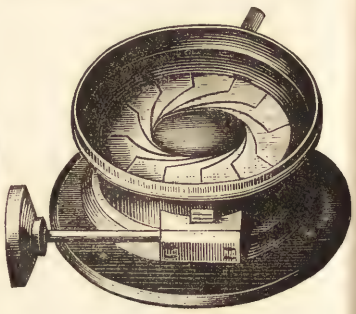

FIG. 24.

fastened to the objective, which is arranged with apertures of different sizes. Even more convenient are the newly introduced *Iris* stops (see Fig. 24), in which the aperture of the stop is enlarged or diminished by a single movement of a lever. A scale attached to the lever shows the size of the aperture. Revolving and Iris stops are very useful in travelling, as they cannot be lost.

The smaller the stop used the sharper the image becomes and the greater the "depth of focus" of the objective, that is, its capability of making sharp widely separated objects.

The size of the aperture is almost always given in terms of the focal length. For instance, if with a focal length of 15 cm. the stop has a diameter of 1 cm. the aperture of the stop is called $\frac{1}{15}$ or $F/_{15}$.

If the diameter of the aperture of an objective is doubled, the focal length remaining the same, the brightness is multiplied four times; if the aperture is divided by three, the light is divided by nine.

An opinion can be formed as to the rapidity or brightness if the diameter of the aperture is divided by the focal length, and the result squared. For instance, you have two objectives. One has 3 in. full aperture and 12 in. focal length; the fraction is $\frac{3}{12}$ or $\frac{1}{4}$. Another has 2 in. full aperture and focal length of 14 in.; its fraction is $\frac{1}{7}$.

The rapidity of the two lenses is in the proportion of $(\frac{1}{4})^2 : (\frac{1}{7})^2 = 16 : 49 = 1 : 3$ (nearly).

The aperture which is here mentioned signifies only the working aperture (see below).

In objectives of similar construction you can, if only the proportion is wanted, set down the actual diameter of the stop by direct measurement instead of this; but with objectives of different constructions you must determine the corrected or "working" aperture.

DETERMINATION OF THE WORKING APERTURE.

Unscrew the back lens from the objective, and with the front lens only focus through an open window an object as distant as possible. Measure the distances from the front lens to the focussing screen and to the stop. Let the first be called *a*, the second *b*. Multiply the fraction $\frac{a}{a-b}$ by the measured diameter of the stop; this gives the true aperture of the lens for the given stop.

DETERMINATION OF THE FOCUS.

Through an open window, and with full aperture, focus a very distant object, and mark the position of the focussing screen on the base board of the camera. Stick a piece of gummed paper of reasonable size on the window, taking care that the focussing screen is parallel to it, and focus till of equal size, and mark this position of the screen as before. The distance between the positions of the screen in focussing a distant object and one of same size gives the true focus.

DIFFERENT TYPES OF OBJECTIVES AND THEIR QUALITIES.

Very divergent demands are made upon photographic lenses. In them are required :—

1. The admission of *much light*, so that the exposure may be as short as possible, especially for very dark objects or those which do not remain still. This can only be obtained by a large aperture and short focus.

2. *Sharpness* up to the edge. This is only to be had with a small aperture (or stop), and is therefore contradictory to the first condition.

3. *Large and flat field.* This demands the inclusion of obliquely falling beams, for which the spherical aberration and curvature of field are very difficult to correct.

4. Freedom from distortion.

5. Freedom from difference of focus (see note on p. 25).

6. Equal distribution of light over the whole field.

7. *Depth.* Power of focussing objects of very different distances from the camera.

It is difficult to fulfil all these conditions, and at

present no universal lens exists which satisfies them all, so different objectives are necessary for different purposes.

In practice most lenses fulfil the fifth condition to a considerable extent, but the rest are only partly satisfied.

Thus a portrait-lens especially answers the first condition (quantity of light), but is deficient in the others; an aplanatic lens and an Euryscope answer the fourth (correct drawing); both excel the portrait lens in reference to conditions three (field) and seven (depth), but are beneath it with reference to quantity of light. The pantoscope and other wide angle lenses surpass all others in field and depth of focus, and equal the foregoing ones in correctness, but give place to them in quantity of light. Depth of focus is only found in instruments with small aperture, most perfectly in wide-angles, least of all in portrait lenses.

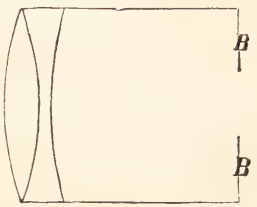

FIG. 25.

The quality of cheapness, which, owing to their construction, can only be fulfilled by single lenses, is one which we can hardly recommend. Achromatic lenses * of the kind have already been mentioned as Landscape lenses (see Fig. 25). They represent straight lines curved at the edge, and only give sharp edges by considerable stopping down by the front stop BB.

* Simple lenses always show prismatic colours, especially at the edge; that is, white images have a coloured border. To avoid this crown and flint glass are used together, so that the focus of the blue and yellow rays coincides. This does not happen if the lenses show difference of focus; that is, they form the chemically active image, which is mainly produced by the blue rays in a different place from that seen with the eye. See Vogel, "Handbook of Photography," Pt. 2.

The portrait objective having an aperture of $\frac{1}{3}$ its focus, and letting through much light, is quite a contrast to the poor light-giver, the landscape lens. This is only used for portraiture by professional photographers, and by amateurs chiefly for flash-light work, as the more light the lens allows to pass the less magnesium is required.

Fig. 22 shows the outside, including the stops.

Fig. 26 shows the inside. A is the front lens, B

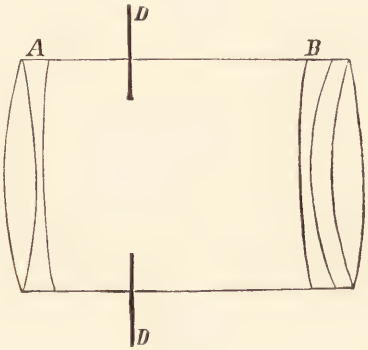

FIG. 26.

the backbone, which consists of two separate lenses; D is the central stop.

The Petzval or portrait objective has found a rival in Voigtländer's Euryscope Systems I. (aperture $F/4$) and III. (aperture $F/4{\cdot}5$), and the anti-planet portrait lens of Steinheil (aperture $F/3{\cdot}15$). Fig. 27 explains the construction of this. The ordinary Euryscope for groups and landscape has an aperture of $F/5{\cdot}6$. The ordinary anti-planet has an aperture of $F/5{\cdot}76$. These two let through most light of all the instantaneous and landscape objectives used by amateurs.

Fig. 28 shows the construction of Steinheil's very useful anti-planet for groups.

But for most purposes apparatus suffice which let less light pass (aperture *F*/6—*F*/8).

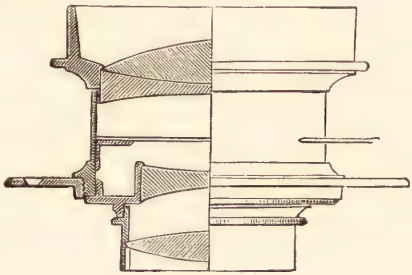

Fig. 27.

If these lenses give fainter light than the portrait lens they surpass the latter in field of view, that is, the extent of the field covered by the objective.

This is best seen by screwing an objective into

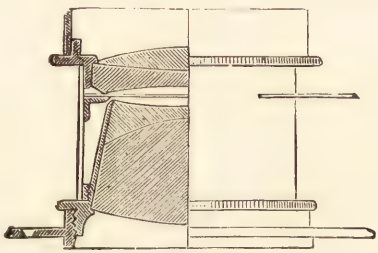

Fig. 28.

a large camera, and looking at the field of view as a circle. From this circle it is required to cut out a quadrangular picture of a particular size.

The following table shows how large the sharp

field must be to cover plates of the sizes given in the left-hand column.

SIZE OF PLATE.						KNOWN DIAMETER OF USEFUL FIELD.	
cm.			in.			cm.	in
9	×	12 =	$3\frac{1}{2}$	×	$4\frac{3}{4}$	15	= 6
12	×	16 =	5	×	$6\frac{1}{4}$	20	= 8
13	×	18 =	5	×	7	22·2	= 9
13	×	21 =	5	×	$8\frac{1}{4}$	24·7	= 10
18	×	24 =	7	×	$9\frac{1}{2}$	30	= 12
21	×	26 =	$8\frac{1}{4}$	×	$10\frac{1}{4}$	34	= 14
24	×	30 =	$9\frac{1}{2}$	×	12	38	= 15

An objective which, with the smallest stop (F/60 —F/80), covers a field of a diameter equal at least to the focus can be considered a good one.

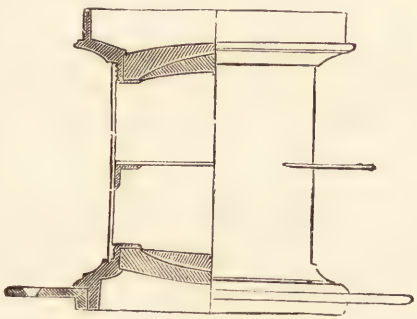

Fig. 29.

The ordinary aplanatic lens and Euryscope are always double objectives, constructed according to the arrangement illustrated in Fig. 29. They are *free from distortion*, their visual angle is mostly over 60°, the diameter of the field somewhere between 1 and $1\frac{1}{3}$ the focus.

The ratio of aperture to focus is *F*/5 up to *F*/8.

Now lenses are also made with a particularly wide angle. The oldest is Busch's Pantoscope, the field of which (90°) is double the focus. Such objectives have of course a very wide angle, but with these exaggerations of perspective are unavoidable. These are only used for taking narrow streets and ravines which it is impossible to get far enough back from the object, or in panorama work.

More recently Steinheil has made a wide-angle aplanatic lens (see Fig. 30) with 100° greatest field, and Voigtländer has constructed a wide-angle Euryscope which has 93° for the greatest angle.

A wide-angle objective is naturally only to be considered a wide-angle for the size of plates for

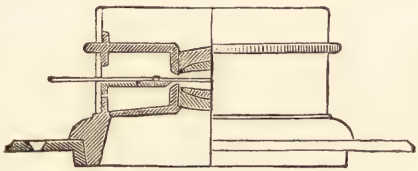

Fig. 30.

which it is designed. If you use such an objective for a smaller plate the large angle of view does not count. For instance, an objective which has an angle of 90° when used with a plate 13 × 18 cm. has only an angle of 45° when used with a 9 × 12 cm. plate.

Quite lately Zeiss of Jena has introduced objectives differing from the Aplanatic and Anti-planet. These are the so-called Anastigmatic and Wide-angle Anastigmatic (see Fig. 31).

The ratio of aperture to focus in these objectives is *F*/7·2 to *F*/18.

Their freedom from flare-spots is remarkable; other lenses often have this fault, which consists in showing

a bright circle in the middle of the picture in sunlight with very clear sky. Remarkable, too, is the small astigmatism of Zeiss's objectives; a fault which most objectives have, and which consists in distort-

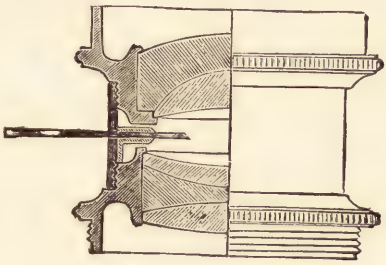

FIG. 31.

ing points in the direction of the radius of the lens. Thence Zeiss calls the lenses Anastigmatic.

Triplet-apochromatic lenses also, of a type quite different from all previous ones, are constructed by

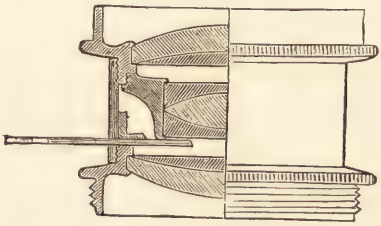

FIG. 32.

Zeiss (Fig. 32). Achromatism is carried to such a length in these lenses that not only two colours (yellow and blue) coincide, but three, bright blue also (line *f*). Anastigmatics like Zeiss's have been also introduced of late by other firms of opticians,

such as Voigtländer of Braunschweig, Krauss & Co. of Berlin, etc.

The above-mentioned objectives are suitable for ordinary work. If you intend to take very distant objects you will find them too small. For this style of work you need a lens of a much longer focus. Cameras with great extension are requisite for this, but are very difficult of conveyance.

Lately Drs. Miethe and Steinheil have made objectives for this class of work with which very distant objects can (in bright light) be taken at any desired size. These objectives go by the name of Telescope and Distant Objectives.*

In working with these it is most important to make sure of the steadiness of the camera, because in windy weather blurring is easily produced.

Of course very distant objects can only be taken in an exceedingly good light.

ON THE CHOICE OF SUITABLE OBJECTIVES.

Among the great number of purposes for which photographic lenses can be used, and the number of instruments existing, varying as to aperture, focus, angle of view, sharpness with certain stops, etc., it is always very difficult in practice for the inexperienced to find their way in an optical price-list.

First of all, consider the size of the plate to be covered.

Suppose an objective which is to let a good deal of light pass at full aperture (ap. $\frac{1}{6}$ to $\frac{1}{8}$) is required, look under the heading *Relative Aperture* or *Ratio of Aperture to Focus.* For instance, do not take Voigtländer's wide-angle for this purpose, but rather Systems IV., V., or VI. (rel. ap. $\frac{1}{5 \cdot 6}$, angle 70°; $\frac{1}{6}$, angle

* J. H. Dallmeyer of London has done the same thing, and describes them as Tele-Photographic Lenses.—*Translator.*

80°; $\frac{1}{7\cdot 3}$, angle 78°). It is easy to choose among these either one of greatest light for instantaneous work and groups, or one of larger angle. The greater the light the less the denominator of the fraction, $\frac{1}{5\cdot 6}$, $\frac{1}{6}$, $\frac{1}{7\cdot 4}$.*

Having chosen a system, look for the list of sizes of plates. For instance, under System V. for plates 13 × 18 = 5 × 7 the objective *o*, with a somewhat short focus (13·8 cm. = $\frac{7}{9}$ length of plate). But *the shorter the focus the more light*, and the field is somewhat increased by it.

If a lens is wanted for both the above uses, choose something dearer (75 marks = 75*s.*), No. VI., with focus equal the length of plate. Go a similar way to work in other price-lists.

Now, besides the optical requirements, amateurs need lightness and ease of carrying, which are not shown by every instrument. Many so-called combination sets have been recommended, such as those, for instance, which Français has issued. (Darlot placed similar ones on the market twenty-eight years ago.) These are combinations of lenses made up of different single lenses which can be screwed together. One transmits much light; another has a large field of view, with angle of 60° with less brightness; a third has a wide-angle, with a want of the previously mentioned qualities, etc. It is easy to make twenty different combinations with such a set. They are very useful if from a given stand-point, which cannot be altered (a look-out point or window), it is wished to take pictures of near or distant objects in which the figures must be of a certain size. The different

* The light varies as the *square* of these numbers. Consequently as $\frac{1}{3\,1\cdot 3} : \frac{1}{3\,6} : \frac{1}{5\,6\cdot 2}$; that is, more than 11·1 : 10 : 6·4. The time of exposure depends *inversely* upon these numbers. If the first objective takes 10 secs., you will want 11 with the second, and 19 with the third.

lenses are screwed together until the object has the desired size. Such a system may be useful in taking objects of very different kinds, such as interiors with short or long distances, seaside scenes, life-size heads, etc.; but for the purposes of most amateurs only three combinations at most are required; the rest are mere lumber, and in travelling it is very inconvenient to be burdened with such a voluminous combination set. Two or three single objectives, which can be carried in the coat pocket, suffice for all cases.

These have the advantage over combination sets of being always ready for use, and also surpass them in sharpness of margin with the same stop, in greater brightness and larger field. Fig. 33 serves to give an idea of what can be done in landscape work from the same standpoint with lenses of different focus.

In the drawing a rough sketch is placed (an artist might say "thrown down") in front of a camera in which three objectives can be put, one with a very short focus, scarcely half as long as the plate, and including an angle of 90°, gives a picture with an extension CC, and is really a wide-angle. BB shows the extension for on objective for a medium-sized field of 60°, in which the focus is $\frac{4}{6}$ the length of the plate. The dotted lines beneath show the extension for an objective whose focus equals the length of the plate, and finally AA gives the extension for an objective where $F = 1\frac{1}{4}$ length of plate. The lines produced to A′, B′, and C′ show how much of the landscape is included in the field of the different objectives.

This will be marked out sufficiently by following the extended dotted straight lines to the marginal points of the landscape laid horizontally towards the camera. It is then easily seen, that with an objective whose focus is nearly equal to half the length of the plate, a perfect representation of the hills at the side

of the valley will be obtained. The objective whose focus is $\frac{4}{5}$ the length of the plate places the picture in the position BB; here part of the side hills will be wanting, at AA (focus $\frac{5}{4}$ length of plate) only the glacier in the background will be included, and that

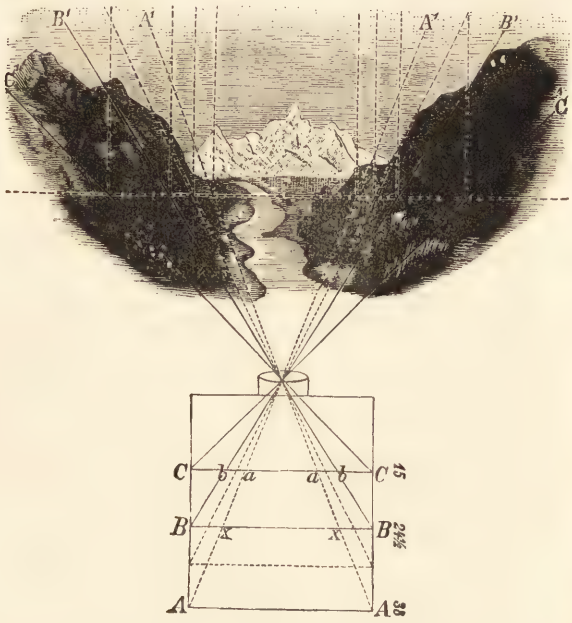

FIG. 33.

not quite completely; but an objective of $F = \frac{5}{4}$ length of plate will have the advantage of making the objects (groups of glaciers) larger; objective $F = \frac{1}{2}$ plate will make them smallest, namely, only $\frac{2}{5}$ as large as the other. With the other objectives the size of

image is in proportion to the focus. The extension $F =$ length of plate is better than $F = \frac{5}{4}$ length of plate. BB gives the best views of the place. At AA the sides of the view are quite lost; at CC they appear unnecessarily broad and large against the small mountains in the distance. The objective whose extension (equal to length of plate) lies between A and B is more suitable for the foregoing purpose than the others, because it makes the glacier look large, while it shows enough of the hills at the side.

Now if the amateur wants to do as much as possible with one objective it should be able to take landscapes and groups. The lens must allow plenty of light for the last, aperture $\frac{1}{6}$ to $\frac{1}{7}$. Those mentioned below are given only as examples.

A. for $3\frac{1}{2} \times 4\frac{3}{4}$ plates :—

1. Voigtländer's Euryscope, System IV., No. 0, focus 12·7 = 5 in., consequently a little greater than length of plate, aperture $\frac{1}{5 \cdot 8}$. Price 70 mks.*

2. Steinheil's Aplanatic, Series III., No. 3, ap. $\frac{1}{6}$, focus $1\frac{1}{5}$ length of plate. Price 57 mks. We consider both these objectives to pass an adequate amount of light. In place of these instruments we might, with equally good results, take a Suter-aplanatic of similar focus.

3. One of Steinheil's Wide-angle Aplanatic, Series I. focus in our example $\frac{3}{4}$ length of plate, or instead of this Voigtländer's VI. Wide-angle Euryscope 00, focus $\frac{2}{3}$ length of plate. Price 66 mks. (This is different in the more recent prices current.) All wide-angles give faint light. Zeiss makes a very good objective with F = half length of plate, the Jena Anastigmatic Wide-angle, Series IV., No. 1, focus=61. Price 64 marks. Also Goertz, Berlin-Schöneberg, Series F, wide-angle 000. Price 45 mks. Hartnack-

* A mark equals an English shilling.—*Translator.*

Potsdam. Its field of view, 90°, answers exactly to the objective in the figure with extension CC.

To 1 belongs also Steinheil's Anti-planet for Groups I., focus 12·5 = 5″. Price 53 mks. Then also Goertz's Amateurs' Aplanatic, No. 7, aperture $\frac{1}{7}$, focus 112 cms. = 44″; and finally Zeiss's Jena Illuminating Instantaneous Objective, Series III., No. 2, focus 12 cms. = $4\frac{3}{4}$″. Price 80 mks.

To 2 belongs also Voigtländer's IV., Euryscope No. 00, focus 17·4 = 7″ (nearly $1\frac{1}{2}$ times plate length), aperture $\frac{1}{5\cdot6}$. Price 90 mks. Zeiss's Triplet No. 3. Price 100 mks. Then Goertz's Recti-planet, focus = 15 cm. = 6″, $1\frac{1}{4}$ length of plate, aperture $\frac{1}{6}$. Price 45 mks.

The objectives under 1 and 2 can also be used as instantaneous lenses, even by stopping down to $\frac{1}{15}$ focus in the open air and clear weather in the summer time. For groups the objectives under 2 are generally used.

B. for 5 × 7 plates :—

1. Steinheil's Aplanatic, XIV., focus 18·9 = 7″ (length of the plate), aperture $\frac{1}{7}$. Price 75 mks. Or the Anti-planet No. 2b, somewhat better in light, resp. 3, focus 16·4 or 18·4 = 6″ or 7″. Price 80 mks.

Voigtländer's Euryscope IV., 00, focus 17·4 = $6\frac{3}{4}$″, aperture $\frac{1}{5\cdot6}$. Price 90 marks. Goertz's Recti-planet No. 2, focus = 18 cm. = 7″, aperture $\frac{1}{6}$. Price 50 marks. Or else Zeiss's Anastigmatic, Series III., No. 4, focus 19·5 = 8″, with full aperture. Price 120 marks.

2. Voigtländer's Euryscope No. 2, focus 25·4 = 10″, aperture $\frac{1}{5\cdot6}$. Price 116 marks.

Steinheil's Aplanatic III. No. 4b, focus = 24 = $9\frac{1}{2}$″, aperture $\frac{1}{7}$. Price 90 marks.

Or the similar Anti-planet with equal focus, No. 2a, 24 cm. = $9\frac{1}{2}$″, aperture $\frac{1}{6}$. Price 105 marks. Goertz's ecti-planet No. 4, aperture $\frac{1}{6}$, focus 24 cm. = $9\frac{1}{2}$″. Price 70 marks.

No. 3 Wide-angle :—

Steinheil W W No. 2, focus = 12·1 = $4\frac{3}{4}''$. Price 64 marks. Hartnack Wide-angle.

Goertz, Wide-angle 00, focus 95 cm. = 4″. Price 50 marks.

An amateur whose means are limited is recommended to procure, as a universal instrument, one whose focus is about equal to the length of the plate. (See above under A and B, No. 1.)

THE PRESERVATION AND CLEANING OF LENSES.

Objectives are best kept in a case lined with velvet or soft leather, to protect the soft glass from almost every scratch. To prevent dust from settling in the slit made for the stop it is as well to leave the stop always in the objective.

A little piece of clean soft wash-leather should be used for the removal of dust.

Stops which have lost their coating from long use should be warmed over a spirit-lamp, and then plunged into a solution of 5 parts copper and $\frac{1}{2}$ part silver in 20 parts nitric acid. They should, without washing, be heated till they become quite black, and then rubbed over with oil.

3. Instantaneous Shutters.

The different kinds of instantaneous shutters. Exposures up to 1 or $\frac{1}{2}$ second are made by means of the cap of the objective, but for smaller exposures what are called instantaneous shutters are used.

Instantaneous shutters are placed either in front of or behind the objective, or in the place of the stop. Recently shutters have often been placed immediately in front of the plate. In the latest constructions a blind, with a slit in it, is rolled in front of the plate in a regulated slot so that it exposes one part of the plate after another, whilst in other shutters, which are in

the objective, the whole plate is exposed at once. In taking quickly moving objects the exposure at different times of the parts of the plates produces distortion.* But this shutter has the advantage of using the full aperture of the objective during the whole exposure, which is not the case with the others.

One of the simplest and cheapest patterns is the *drop shutter* (see Fig. 34), which consists of a screen of wood or metal provided with an aperture which moves in a frame fixed to the lens. The duration of the exposure depends upon the speed or slowness with which the aperture in the sliding piece glides past the

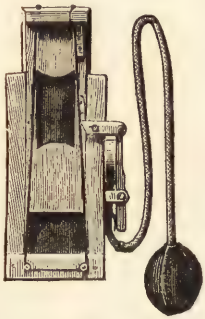

FIG. 34.

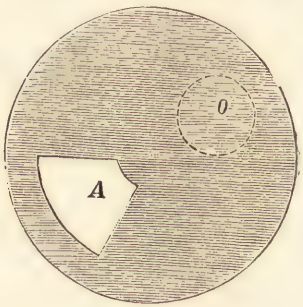

FIG. 35.

lens. To make the bar move quickly it is hastened by a spring or an india-rubber cord. If no great speed is necessary, it is allowed to fall by its own weight.

The release of this shutter is usually pneumatic, and is caused by pressing an india-rubber ball, which is connected by a pipe with another ball. The latter is distended with compressed air, and pushes aside a spring lever, by which the shutter is set in motion.

Rotating shutters are also much liked. They con-

* This, according to an article in the *Amateur Photographer* of July 24th, 1891, is a mistake.—*Translator.*

sist of a blackened piece of metal (see Fig. 35), with a piece cut out of it at A; it is sent past the objective O by a spring.

There are numerous types of instantaneous shutters, a description of which would be too long to be given here. Of dearer shutters, those of Steinheil and Voigtländer, as well as Thury and Amey, are to be recommended.

A simple instantaneous shutter, introduced by H. W. Vogel, which can easily be prepared at home, is shown in Fig. 36. The whole is simply nothing more than a piece of pasteboard covered with black velvet to prevent reflection, 20 cm. = 8″ broad and 30 = 12″ high, for a 13 × 18 = 5 × 7 apparatus. In the middle is a slit O, which is cut out with a knife; its height is equal to the diameter of the objective. When all is ready for the exposure, hold the under part of the pasteboard close before the objective, take the cover with the other hand, and push the card up so as to close the lens. Then wait for the right instant, and quickly move the card straight downwards, so that the opening O passes by the objective, and the upper part of the card covers it again. It is necessary that the objective is not touched in passing the card over it. To avoid this, bend the card to form a flat arc, the convex side of which is towards the lens. One accustomed to this shutter can make an exposure of $\frac{1}{40}$ second with ease, but it can also be protracted a long time if wished. In clear sunshine it may happen that the card is too brightly illuminated, and by an awkward movement light may be reflected

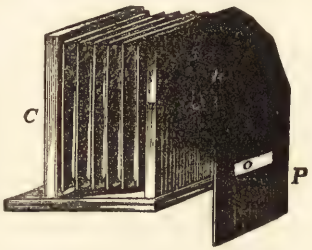

Fig. 36.

into the objective. To prevent this, a piece of black velvet S is necessary, somewhat broader than the camera, and nearly half as long as the card. This piece of velvet is fastened to the latter as well as to the camera by tacks. By this means very bright rays of light coming from above are cut off. If it is wished to use the velvet instead of the cap, it must be doubled in this part, as a single layer of velvet transmits a faint light.

In purchasing an instantaneous shutter attention should be paid to the following points :—

1. The shutter should be as simple as possible and solidly made, yet not too heavy. Very complicated shutters easily get out of order, and are unnecessarily expensive.

2. The shutter should not shake the apparatus, or it will blur the image. It can be tested for this fault by taking some fixed object.

3. The shutter should have an arrangement for regulating its speed.

4. Instantaneous shutters which are placed in the position of the stop of the objective cannot be used with different stops ; there are many such shutters with one fixed unchangeable stop.

DETERMINATION OF THE SPEED OF A SHUTTER.

The speed necessary for an instantaneous shutter is regulated by the speed or slowness of movement of the object to be taken. The following table, compiled by Eder, gives an approximate idea of the time of exposure required for moving objects.

	Time of Exposure. Seconds.
Laughing children, tableaux vivants, etc., for which one can wait for a moment of rest, and then expose by means of a slow shutter ...	$\frac{1}{5}$ up to 1.

	Time of Exposure. Seconds.
Trained dogs, cats, etc.	$\frac{1}{2}$ down to $\frac{1}{10}$.
Street scenes from an upper window, according to size of figures ...	$\frac{1}{20}$,, $\frac{1}{50}$.
Grazing cattle or flocks of sheep with open sky	$\frac{1}{20}$,, $\frac{1}{30}$.
Moving ships at a distance of 500 to 1000 yards	$\frac{1}{20}$,, $\frac{1}{30}$.
Moving ships of larger size and less distance	$\frac{1}{50}$,, $\frac{1}{150}$.
Animals which are to move transversely, and appear 1″ to 2″ high in the picture (as Zoological Gardens pictures)	$\frac{1}{50}$,, $\frac{1}{100}$.
Jumping and trotting horses, flying birds, running men, etc. ...	$\frac{1}{100}$ to $\frac{1}{400}$ and $\frac{1}{1000}$.

The speed $\frac{1}{50}$ of a second is sufficient for most work.

Of course the speed of the shutter must not be unnecessarily increased if under-exposure is to be avoided. Objects which are far away from the camera require a slower motion than those which are very near to the apparatus; for this reason very quickly moving objects are usually taken at a somewhat greater distance.

The following table gives the longest exposures permissible for moving objects of different distances. Longest time allowed for velocity of object in a second.

Distance of Object.	1 Yard.	5 Yards.	10 Yards.
*100 times focus	$\frac{1}{100}$	$\frac{1}{600}$	$\frac{1}{1000}$
500 ,,	$\frac{1}{20}$	$\frac{1}{100}$	$\frac{1}{200}$
1000 ,,	$\frac{1}{10}$	$\frac{1}{50}$	$\frac{1}{100}$

* For instance, 18 yards with object of 7″ focus.

Instantaneous shutters whose speed can be regulated are often furnished with a scale showing the speed.

The certainty of these statements, however, is in most cases very doubtful, and they are therefore best considered merely as approximating to the swiftness of the shutter.

According to Weber, the velocity of shutters is best determined in the following manner:—

Expose half a dry plate for one second to light from an opal glass, or a screen covered with white paper. To prevent the exposure of the other half, draw the shutter of the dark slide only half out. Then take the plate into a dark room and reverse its position, putting the exposed side, which at first was on the left hand, on the right; then put the dark slide into the camera again, and raise the shutter of the dark slide a little way, so that about an eighth of the unexposed part of the plate is exposed, then set the instantaneous shutter in motion 10 times. Raise the shutter so as to expose another eighth, and work the instantaneous shutter 20 times. Keep on to the end with this, and you will obtain divisions which have had 80, 70, 60, 50, 40, 30, 20, and 10 shutter-exposures. Now develop the plate; the half which has been exposed for a second darkens all over alike, the other half unequally, according to the number of exposures. It can be easily seen in which part the intensity equals that of the half which was exposed for a second.

For instance, if the part which has received 50 exposures satisfies this condition, the shutter must give an exposure of $\frac{1}{50}$ of a second.

There has recently been introduced commercially, by the firm of Dr. Hesekiel & Co., Berlin, a timepiece for the determination of the speed of instantaneous shutters.

This watch consists essentially of a white index,

which moves with a regular speed by means of a weight over a black dial-plate, marked out into a hundred parts.

If the watch is photographed while it is going, the index will appear more or less broad according to the length of exposure. For instance, if it makes one revolution in a second, every division-mark covered by its width counts as $\frac{1}{100}$ of a second length of exposure.

4. Detective Cameras.

Instantaneous work can be done with every apparatus which has an objective transmitting enough light (aperture $\frac{1}{5}$ to $\frac{1}{8}$), and a rapid shutter. But special apparatus are also constructed for this purpose, the so-called Detective Cameras.*

They have the great advantage that in consequence of their unobtrusive exterior they can pass unremarked, which is very useful in taking pictures of people, etc.

The apparatus is generally used without a stand; and is arranged to hold a considerable number of plates (12 to 24), or fitted with a roll-holder.

The objective is generally put in position by the manufacturer, and has a fixed stop, so that the apparatus is always ready for use, and for the exposure you have only to draw up the dark slide and push it down.

There are numerous detective cameras on the market of different constructions and various prices (from £1 to £13).

Complete apparatus is fitted with an arrangement to regulate the speed of the shutter as well as to change the stop and the position of the objective (by means of a scale, which gives the position of the latter for objects of different distances). It

* The author uses this kind of apparatus exclusively for instantaneous work, especially in travelling.

also has what is called a *view-finder*; that is, an arrangement by means of which the object to be taken can be observed during exposure.

Fig. 37 shows such a view-finder. The image formed by the objective O falls upon a sloping mirror S, and is reflected on to the screen M by this. A flap K serves to cut off the light, which would render the observation of the image difficult.

Another kind of view-finder is an arrangement like the Iconometer, further described below. Both

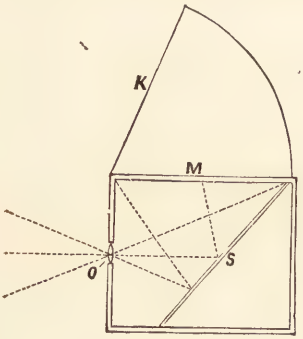

Fig. 37.

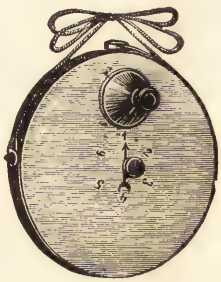

Fig. 38.

kinds of finder share the advantage that you can control the image (which the objective of the apparatus gives) while taking the picture, so that you can always be sure of having the desired object on the plate.

The description of the numerous, often very ingeniously constructed, cameras would take up far too much room in this book; a few only of the best known are described here as examples.

Stirn's Detective Camera, the most secret of all secret cameras (see Fig. 38), consists of a round

flat metal box, which carries the objective in a conical addition. In the box is a round, movable dry plate, upon which six round pictures of the size of a dollar can be taken. The instantaneous shutter is in front of the plate. The camera is also made for four larger pictures on a round plate, as well as for four single plates. In use, the apparatus is carried under the coat, and the objective pushed through the button-hole. The shutter is set in motion by pulling a string.

Magazine cameras with changing-bag. These consist of a wooden box (see Fig. 39) fitted with an opening for an objective, and a magazine for plates (12 to 24) at the back. The plates are in open metal sheaths. When the first plate has been exposed it is raised by means of a lifting arrangement into a light-tight leather bag, situated above the magazine. It is then taken with the fingers and slid to the back; the apparatus is then ready for a fresh exposure. This method of changing is repeated as long as the plates last. Steinheil of München, Hesekiel & Co., as well as Stirn, Berlin, Dr. Krügener, Frankfort, etc., make this or similar cameras.

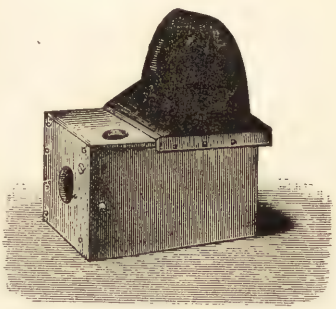

Fig. 39.

Complete cameras of the kind are fitted with two view-finders for vertical pictures and those taken horizontally, and also have arrangements for changing the stop and regulating the speed of the shutter.

Among other magazine cameras, Krügener's Simplex may be mentioned.

This consists of a box the length of which is divided inside into two equal parts by a horizontal wall. The upper part is divided again, but unequally, and while the small back space serves as a store for plates, the larger front one contains an automatic view-finder, consisting of an objective and glass plate, with a focussing screen (as shown in Fig. 37). The whole of the lower part of the camera

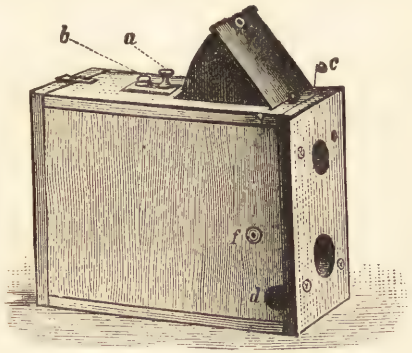

FIG 40.

holds the working apparatus, and carries the exposed plates at the back.

The sensitive plates, which are in a little metal frame, are in the plate-magazine at the top, and are brought down into the lower part of the camera one by one, for exposure, by means of a push (*a*). The exposed plates are pressed back by those coming down. The instantaneous shutter is pulled up by the cord (*c*), and released by pushing the knob (*d*). With the objective in the usual place, the camera focusses objects about five yards off. In taking closer

ones the knob (*f*) should be pulled out a little way, by which means the objective is put in a suitable position for taking them. This apparatus has the great advantage that the view-finder shows the image the same size as it will appear on the plate.

The magazine cameras mentioned above generally have the rotating shutters, described on p. 38, placed behind the objective.

Among cameras with the shutter in front of the plate (see p. 37) the apparatus of Anschütz & Loman may be mentioned.

Lastly, the so-called "Reflex Camera" is interesting, because in it the camera and view-finder are combined (see Fig. 37). The image formed by the objective used is thrown by means of a mirror, which can be folded back, upon a screen above the camera, and can here be focussed. This can even take place if a plate is ready for exposure in the camera, as the mirror intercepts all light coming through the open objective, and throws it upon the screen, and thus the plate is perfectly protected by it.

After the focussing is ended the mirror is turned up by pressure on a knob, which makes the focussing screen opaque, and sets the instantaneous shutter in motion at the same time.

Eastman's Kodak is also very convenient. This is fitted with a roll-holder, which contains material for fifty or more exposures.

In photographing with detective cameras it should be remembered that the camera must be held as nearly horizontal as possible, for distortion is produced by its crooked position or derangement.

Also the apparatus must be held as still as possible while working the shutter, otherwise the image is easily blurred.

II.

ARRANGEMENT OF THE DARK ROOM.

For developing plates a completely darkened room is necessary, lighted only with red light, or with yellow for collodion plates. To prevent the entrance of daylight into the dark room, double doors should be used, or an opaque curtain, to keep out the light when opening the door. Amateurs, who often cannot have access to a perfectly darkened room, can best develop in the evening.

LIGHTING OF THE DARK ROOM.

Artificial light is best to use; daylight can, indeed, be made use of, but is not to be recommended, as its brightness is so variable that it is difficult to judge of the density of the negative. Besides which, daylight is often far too bright, and easily fogs sensitive plates.

Direct sunlight should be absolutely prohibited.

Many different constructions of *ruby lanterns* for gas, paraffin, etc., are in the market. Fig. 41 shows one of the most useful forms. In purchasing care should be taken that the lantern is not too small, and is provided with sufficient ventilation, as otherwise after some use the glass easily cracks from over-heat. It is naturally essential that it is perfectly light-tight.

The author uses a lantern which is glazed with red in front and yellow at the sides. Through the yellow

sides, which can be shut by sliding screens, a tolerably bright light falls upon a shelf of bottles of developing solution, etc., so that they can easily be seen.

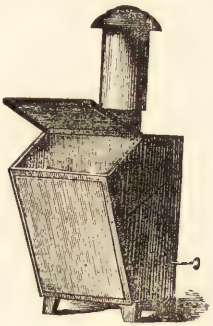

Fig. 41.

For travelling purposes a small lantern with a red cylinder is used (see Fig. 42), in which a candle or small benzine flame is burnt. Folding lanterns, in which red linen takes the place of glass, are also much used. These have the advantage of being light and unbreakable; but unfortunately the red linen often allows a considerable amount of blue and green light to pass through, so lanterns of this sort should be used with great caution and with very faint light.

Fig. 42.

The selection of the ruby glass is very important. What is called red copper-glass is employed.* A good ruby screen will only transmit red light, and can be tested in this by a spectroscopic examination.† Unfortunately, most screens (including those sold by photographic dealers) do not satisfy these conditions, but allow a consider-

* Red gold-glass is useless.

† At the photo-chemical laboratory of the Technical High School at Berlin spectroscopic examinations of screens are undertaken.

O. Perutz in München sells red screens spectroscopically tested.

able amount of blue and green light to pass as well as red, which may fog the plate. The same thing applies to the red cylinders.

Large red screens are often good in part, and have other parts quite useless, so that they must be examined piece by piece by the spectroscopic test, for if one side is proved to be all right, it is not safe if the other side is of no use. Red screens that transmit either blue or green light can sometimes be used by putting two together. A good red screen need not be excessively dark. The author uses a screen which, though it allows only red light to pass, is much brighter than many useless ones which transmit blue and green as well as red.

If you have no spectroscope to arrange a test for the red screen, you can satisfy yourself whether it transmits pernicious light by exposing a dry plate half covered with black paper to the lantern at the distance of half a yard for half a minute, and then develop it. If the screen transmits pernicious light, the exposed end darkens in the developer.

In developing dry plates a *dark brown screen* is sometimes used. This should absorb all the blue and the greater part of the green light, otherwise fog easily results. A good red screen is, however, rather preferable. In developing colour-sensitive plates only a red screen ought to be used.

The combination occasionally recommended of a yellow and a green screen is much to be condemned. Green screens absorb red, and consequently throw the least amount of working light upon the plate.

ARRANGEMENT OF THE DEVELOPING TABLE.

Fig. 43 shows the scheme of arrangement of a developing table in the photo-chemical laboratory of the Royal Technical High School at Berlin. B is a

stone basin,* provided with an outlet in the middle, and supported by two posts SS. Right and left of this basin, as well as above and below it, are shelves R, which hold the developing dishes and solutions. The lantern L is glazed in front with red and at the sides with yellow,† so that the chemicals on the shelves can be easily distinguished. The products of combustion are carried off from the lamp directly into the open air by means of a sheet-iron pipe (T); this

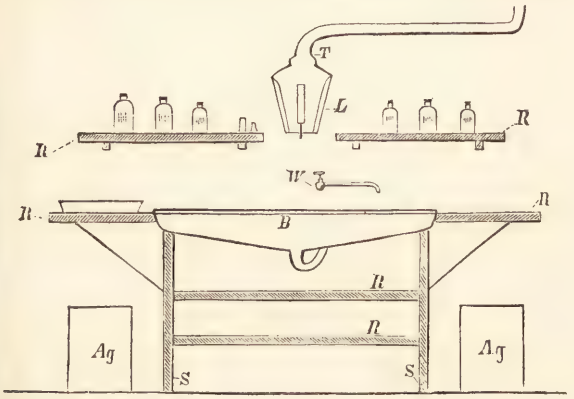

FIG. 43.

prevents the over-heating of the dark room. W is a water-pipe, which can be opened or shut by one movement. The tap fixed on it serves to regulate the force of the water. The pots or barrels Ag are for the preservation of the residues containing silver.

If no arrangement can be made for the water to run away, a good-sized sheet-zinc reservoir, with a tap

* Such basins are to be had in clay-ware from March in Charlottenburg.

† The yellow sides can be closed by tin flaps.

for the discharge, can be used. The stone basin, also, may be replaced by a wooden box, with a water-tight lining made of zinc.

DISHES FOR DEVELOPING, FIXING, ETC.

For each operation a different dish is used; it is therefore inadmissible to use a fixing dish, for instance, for developing or intensifying, as sometimes the worst faults originate in this manner.

In order to prevent changing them, each dish should be marked outside with a conspicuous inscription showing its purpose.

Dishes made of papier-mâché are very useful; they are cheaper and considerably lighter than those of glass or porcelain, and are also unbreakable. For strongly alkaline developing solutions (hydrokinone with caustic potash), however, glass or porcelain dishes are preferable, for the varnish of the papier-mâché is soon destroyed by the alkaline solution.

After use the dishes should be immediately washed and turned over. Faulty places in papier-mâché dishes may be smeared over with Asphaltum-lacquer, after thorough drying. Dishes of celluloid have recently been introduced. They are even lighter than those of papier-mâché, but have the fault of easily losing their shape if solutions are allowed to stand in them too long.

BOTTLES TO HOLD THE DEVELOPER.

The developing solutions are kept either in ordinary corked or stoppered bottles, or in tubular bottles with a tap, as shown in Fig. 44. The developer in the bottle F flows through the bent glass tube G (which is furnished at the end with a piece of rubber pipe), as soon as it is opened, by pressing the tap Q. The little tube L serves to let in air, and is curved to prevent the admission of dust.

On the top of the developer is a layer of vaseline oil, $\frac{1}{2}$ in. thick, which perfectly protects the developer from touching the air, so that it cannot be oxidised,* and therefore keeps good for a long time. Those who have no tubular bottle at hand can use the arrangement sketched in Fig. 45, which can be understood from the figure without further explanation.

To fill the bottle with fresh developer it is merely necessary to pour it in, and the displaced oil soon collects again at the top of the bottle.

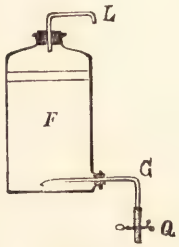

FIG. 44.

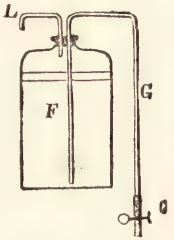

FIG. 45.

To *measure out the developing solutions*, a glass measure holding 4 oz. is needed, as well as a smaller one to hold $\frac{1}{2}$ oz. Further, a dropping-bottle is required to add the bromide solution.

WASHING APPARATUS.

The fixed plate must be well washed until all the remains of the fixing-bath are entirely removed.

* The layer of oil is of course superfluous with solutions which do not oxidise, *e.g.* with oxalate developer the solution of oxalate of potassium, with pyrogallol, hydrokinone, eikonogen and metal developers, the carbonate of soda or carbonate of potash solution.

Single plates are washed by laying them in the stone basin B (Fig. 43), and allowing water from the tap W to flow over them, or else by leaving them for a longer time in a dish of water, which must be changed five or six times. Different washing apparatus has been constructed for washing several plates at once.

The simplest is a flat box of sheet zinc (about 8 in. broad, 24 in. long, and 1 in. high for 5 × 7 plates), in which the plates lie side by side. The box is placed somewhat obliquely, so that the water flows over the plates.

For a larger number of plates several similar boxes

Fig. 46.

may be placed one above another in an iron stand, so that the water flows from the upper boxes into the lower ones (see Fig. 46). This washing apparatus has this advantage over others, that in it plates which have already been partly washed are not soiled again by those newly put in, supposing that the yet unwashed plates are put underneath, so that the water containing fixing solution does not come in contact with the other plates.

In travelling plates should be placed in a vessel of water for some hours to remove the greater portion of the fixing solution. It is well to give such partially washed plates an additional thorough washing on reaching home.

DRYING RACKS.

The plates, when well washed, are put in a plate-rack to dry (see Fig. 47).

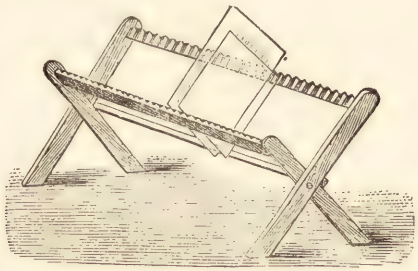

Fig. 47.

One with *oblique notches* should be used (see Fig. 48).

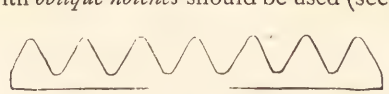

Fig. 48.

The plates do not stand firmly on a rack with straight notches (see Fig. 49).

Fig. 49.

If no rack is at hand, the plates may stand on blotting-paper, leaning against the wall.

Folding racks of tin or wire are useful in travelling; these can also be used for washing plates, as they can be placed in a vessel of water.

III.

REVIEW OF PHOTOGRAPHIC WORK.

Landscape and Architecture.

Care should be taken in setting up the apparatus that it stands perfectly horizontal, or distortion, which makes architectural pictures useless, is unavoidable. It is best to use a box-level.

Too brilliant lighting should be avoided, as it makes too much difference between light and shade. It is therefore advisable to forbear working at midday in the height of summer if you wish to produce artistic pictures. Very good results may also be obtained when the sun is covered with a light, half-transparent veil of clouds. The most favourable position for the sun is behind the camera, towards one side.

It is only possible to photograph against the sun under very favourable circumstances; for instance, if a tree or house screens the objective from the direct sunlight. *Direct sunlight ought never to fall upon the objective.*

Brilliantly white objectives, such as marble statues against a background of foliage, are best taken under a cloudy sky.

The right *choice of a standpoint* is very important. Here, taste and artistic feeling are necessary for successful work. What is called an *Iconometer* may be used with advantage in finding the right standpoint, to avoid troublesome alterations of the camera's position. Baltin's Iconometer (see Fig. 50) is to be recommended.

It consists of a nickel-plated measuring rod, with millimetre divisions, upon which is fastened a small movable frame. One end of the rod carries a small screen, pierced in the middle by an opening.

On looking through this opening and through the frame, so that the eye surveys a larger or smaller portion of the landscape according to the distance of the frame from the screen; for each objective ascertain by trial at which mark the frame should stand so that the part of the landscape seen by the eye is imaged upon the focussing screen.

Parallel lines, as well as too rigid symmetry, should

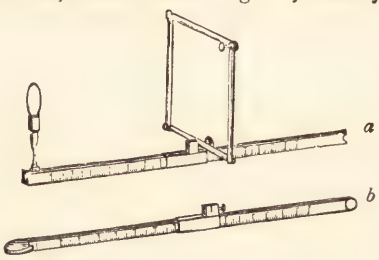

FIG. 50.—*a*, unfolded; *b*, folded.

be avoided in pictures as much as possible. For instance, a view down a street should not be taken from exactly the middle, but rather from the side, to prevent undue symmetry in the picture.

The front view of an object is seldom as picturesque as a perspective (see Fig. 51).

A picture must always have a fitting balance. For instance, the middle point of the arch of a bridge should not be left unsupported, as in Fig. 52. The foreground is also of great importance to the beauty of a picture. Pictures which have only a homogeneous flat plain without relief as foreground are seldom picturesque.

The picture should be carefully arranged so as not to have too much or too little foreground. In all the best tourist cameras the objective board can be moved up or down. If it be moved *up* the foreground is diminished; if *down*, it is increased.

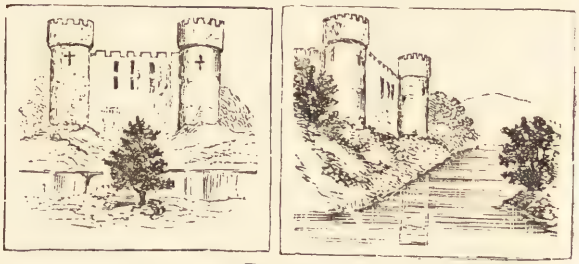

FIG. 51.

The movement of the objective board is often not sufficient to take very high objects, such as church steeples. In this case it is necessary to turn the whole apparatus so as to slope upwards.

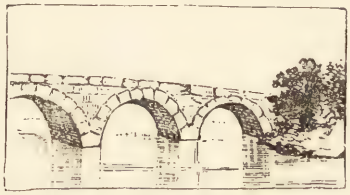

FIG. 52.

In order to prevent distortion the focussing screen must always be kept vertical by means of the swing arrangement attached.

Wide-angle objectives may be used if their exaggeration of perspective does not matter.

PHOTOGRAPHY OF DRAWINGS, PAINTINGS, ETC.

Place the apparatus horizontal, and take care that the focussing screen stands exactly parallel to the object to be taken. If this is not the case, distorted images are produced, such as a trapezium from a square. Of course for this kind of work objectives free from distortion must be used, not a portrait lens, for instance.

It is important also that the object to be taken should be lighted with absolute uniformity.

The upper part of a large drawing is usually much brighter than the lower part, because it is nearer the glass roof of the studio. In this case an equable lighting is obtained by means of a suitable reflector, a looking-glass or boards covered with white paper.

For taking *line-drawings* the wet collodion process is best, and is in practice invariably used for this purpose. It is, however, possible to make good reproductions of line-drawings with dry plates.

One of the most difficult tasks is photographing *paintings*. With shiny paintings care must be taken, by means of suitable lighting, that every vestige of reflection, which would show itself like a black mark in the negative, is avoided. To ascertain whether a picture is properly lighted, place the head in front of the objective, and view the picture from there. No vestige of reflection must be allowed to show.

Very dark pictures, as well as those with great contrasts, for instance, a bright head against a very dark background, are best photographed in the open air, in direct sunlight.

Pictures which are especially difficult to take often have to be retouched in the negative.

It is self-evident that colour-sensitive plates are necessary for taking coloured pictures. The following tables, compiled by Steinheil, may be used in reducing or enlarging a drawing or painting to any desired size.

TABLE FOR EASY DETERMINATION OF THE DISTANCES REQUIRED FOR ENLARGEMENT OR REDUCTION BY PHOTOGRAPHY.

I. Reduction.	II. Extension of Camera.	III. Distance of Object.	I. Reduction.	II. Extension of Camera.	III. Distance of Object.
1	2·00	2·00	6·5	1·15	7·50
1·1	1·91	2·10	7·0	1·14	8·00
1·2	1·83	2·20	7·5	1·13	8·50
1·3	1·77	2·30	7·8	1·12	9·00
1·4	1·72	2·40	8·5	1·12	9·50
1·5	1·67	2·50	9·0	1·11	10·00
1·6	1·62	2·60	10·0	1·10	11·00
1·7	1·59	2·70	11·0	1·10	12·00
1·8	1·56	2·80	12·0	1·09	13·00
1·9	1·53	2·90	13·0	1·08	14·00
2·0	1·50	3·00	14·0	1·08	15·00
2·1	1·48	3·10	15·0	1·07	16·00
2·2	1·45	3·20	16·0	1·07	17·00
2·3	1·43	3·30	18·0	1·06	19·00
2·4	1·42	3·40	20·0	1·06	21·00
2·5	1·40	3·50	22·0	1·05	23·00
2·6	1·38	3·60	22·0	1·04	23·00
2·7	1·37	3·70	24·0	1·04	25·00
2·8	1·36	3·80	26·0	1·04	27·00
2·9	1·34	3·90	28·0	1·04	29·00
3·0	1·33	4·00	30·0	1·03	31·00
3·2	1·31	4·20	35·0	1·03	36·00
3·4	1·29	4·40	40·0	1·02	41·00
3·6	1·28	4·60	45·0	1·02	46·00
3·8	1·26	4·80	50·0	1·02	51·00
4·0	1·25	5·00	60·0	1·02	61·00
4·5	1·22	5·50	70·0	1·01	71·00
5·0	1·20	6·00	80·0	1·01	81·00
5·5	1·18	6·50	90·0	1·01	91·00
6·0	1·17	7·00	100·0	1·01	101·00
Enlargement. I.	Distance of Object. II.	Extension of Camera. III.	Enlargement. I.	Distance of Object. II.	Extension of Camera. III.

Use of the table. The greatest diameter of the object and that of the picture to be obtained must be expressed in similar terms.

If the picture is to be larger than the object, it is a case of enlargement, and the headings at the bottom of the table are to be used; if the picture is to be smaller than the object, reduction is intended, and the headings over the table are used.

If object and image are to be the same size (enlarged or reduced 1 time) you have the actual size.

To determine the proportion of the enlargement or reduction you divide the smaller number into the greater. Look out the resulting number in column I., take the numbers opposite it in columns II. and III., and multiply these by the focus of the objective, in order to find the desired lengths of the extension of the camera and distance of the object. For instance, a map of 40 cm. diameter is to be reproduced with a diameter of 25 cm. Because the picture is to be smaller than the object, it is to be reduced 1·6 times.

The No. 1·6 is found in column I.; opposite it, in column II., is found 1·62 for the extension of the camera, and in column III. 2·60 for distance of object. If the focus be 40 cm., it gives $1{\cdot}62 \times 40 = 64{\cdot}8$ cm. for the extension of the camera, and $2{\cdot}6 \times 40 = 104$ cm. distance of the object. All distances count from the stop of the objective.

PORTRAITURE.

Portraiture is less satisfactory than landscape work with amateurs, because of the restlessness of the sitters and the difficulty of posing and lighting. For posing and lighting in portraiture see H. W. Vogel's "Photographische Kunstlehre" (R. Oppenheim, Berlin). Here a few short notes only can be given upon the subject of portraiture indoors and in the open air.

The right choice of position is essential for obtaining

good portraits in the open air. Do not work in direct sunlight, but always in shade or under a cloudy sky. With regard to the lighting of the place, light from above or too much in front is to be avoided.

Never take portraits so that the figures extend into the sky, but choose a suitable background. A dark opaque wall of leaves answers very well. A suitable background can also easily be made by stretching out a grey or brown cloth. In this you must take care that the colour of the background is not similar to that of the clothes of the sitter. For instance, do not place a sitter dressed in white in front of a white background.

In indoor portraiture you often have to combat the difficulty of unequal lighting. The side of the face turned towards the window is always much brighter than that towards the room. This may be prevented by fitting up a reflector on the shady side. For a reflector a stretched white cloth or paper can be used. The nearer the reflector is to the object the brighter it makes the shaded side. Remember that the contrast between light and shade in photography exceeds that of nature.

PORTRAITURE BY MAGNESIUM FLASH-LIGHT.

For some years portraiture by flash-light has been much favoured, especially by amateurs. Two kinds of magnesium flash-light are known, the real flash-light and blowing magnesium through a flame.

The first is an explosive mixture of magnesium powder and saltpetre or potassium nitrate, which burns instantaneously (in about $\frac{1}{40}$ of a second) with great brilliancy. Such "lighting powder" was first used in portraiture by Gädicke and Miethe. Magnesium flash powder can be bought ready for use; for making it at home Gädicke and Miethe's instructions are to be recommended. They are as follow

30 parts potassium nitrate,
15 „ magnesium powder,
5 „ sulphide of antimony.

The potassium nitrate and sulphide of antimony must be pounded separately, not together, or an explosion will result. It is best to buy both in the form of powder, so that it is only necessary to crush the little lumps in it.

The mixture of the separate substances should take place upon a clean smooth sheet of paper (not in the mortar !) with a piece of cardboard. The powder, when ready for use, should have an homogeneous grey colour, in which the various substances are indistinguishable. It is very inflammable, and ought never to give off fumes in preparation.

Another formula for the preparation of magnesium flash powder is the following by Eder :—

10 parts powdered permanganate of potash,
10 „ magnesium powder.

This powder burns with somewhat less smoke than the preceding.

For taking single persons Gädicke and Miethe give the following advice :—

Place the sitter in front of a bright background, which should be about a yard away, or otherwise the shadow falls on it.

Imagine the sitter's head to be a central point, and from it draw straight lines to the objective and the spot where the magnesium powder burns ; these lines are to include an angle of 30°. A reflector should be used to light up the shadow side ; a stretched piece of cloth or paper can be used.

Imagine another line drawn from the sitter to the opposite side of the source of light, which also makes an angle of 30° with the middle line drawn to the objective; place the reflector in this line, and finally move it so as to be perpendicular.

The source of light should be about a yard from the sitter's head. Remember that it should be somewhat higher than the head, about from 8 to 12 in. The reflector should be from 32 in. to 1 yard distant from the sitter. The nearer it is the brighter the shadow side.

For this work an objective which transmits as much light as possible is required, or an objective of weaker light (aplanatic, etc.), with a large stop. To take a cabinet half-length picture with a portrait objective (see p. 25), with the smallest stop, 15 grs. of powder is needed. With an aplanatic, which gives much less light, almost as large a quantity is required with full aperture.

For groups, as the powder must be burnt at a greater distance to ensure equal lighting, a greater quantity is necessary, as light diminishes with the square of the distance from its source. Consequently at double the distance mentioned above four times as much powder would be needed.

Large quantities of powder should be sprinkled in a long streak, not placed in a heap.

When all is ready for the exposure, the light of a paraffin lamp is thrown on the person to be taken, and the apparatus set up. Then the dark slide is slipped into the camera, open the shutter while the objective is still closed, and then take off the cap after moving the paraffin lamp aside, so that the light cannot fall upon the objective. Then the powder is ignited, and the objective covered again with the cap

It does not matter at all if the room is dimly lighted while the powder is burnt and the objective closed again ; weak light has no effect on the plates. Work may be conducted without fear in a half dark room, or in one lighted by paraffin lamps.

Take care that the magnesium light does not fall directly upon the objective. For this reason the

powder should be burnt behind a pasteboard screen, or something similar which shields the lens from the direct light. It is best to use a kind of lantern, painted white inside, over an open wooden box nearly a yard long, half a yard wide, and 6 inches high. This box is placed sideways so that the open side faces the object to be taken, while the back shields the objective from direct light.

The powder is burnt upon a piece of whitened tin. To ignite it a piece of smouldering wood, or, better still, a strip of filter paper soaked in a saturated solution of potassium nitrate, and dried, $\frac{1}{3}$ inch broad and 2—4 inches long, is placed on edge, pushed into the powder, and lighted.

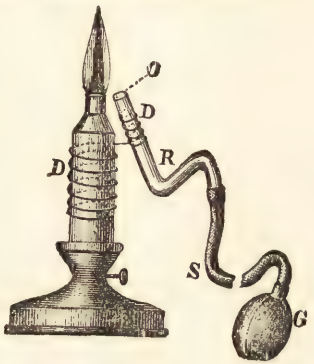

FIG. 53.

The second kind of magnesium flash-light is produced by blowing magnesium powder (without any added substances) quickly through a flame; it burns with great brilliancy, but slower than the first kind.

Many kinds of "flash-lamps" have been constructed, which cannot be more fully described here; those of Schiem are especially to be recommended. A flash-lamp which can easily be made at home is shown in fig. 53. This consists of a benzine light, to which a little curved glass tube R is fastened by means of a spirally curved iron wire. The tube is filled by means of an indiarubber tube S, in connection with a rubber ball *G*, provided with a

valve. The powder is put into the glass tube at *o* (as much as will lie on the blade of a penknife will be enough), and blown through the flame by pressing the rubber ball.

This process can be performed in the way given above, that is to say, by placing one or more lamps on one side, and lighting up the dark side by means of a reflector; but a lamp can also be used instead of the reflector, for instance, using two lamps on the bright side and one on the shaded side.

The advantages of this process are, that several lamps can be ignited at once by pressing a rubber ball, which is in connection with all of them by means of tubes, and that somewhat less powder is required. It is also unnecessary in this case to shield the objective from direct light.

INSTANTANEOUS WORK.

It is necessary in this, as in all other work, to take care that no direct sunlight falls upon the objective. Instantaneous work can only be undertaken in a good light; it is, for instance, quite useless to attempt it in a room or a shady wood. In winter it can only be done at noon, and then only in a good light.

An objective transmitting as much light as possible is needed, with not too small a stop. They must not be stopped more than to $\frac{1}{15}$ or $\frac{1}{20}$ of their focus at most. In using an Aplanatic or Euryscope (ratio of aperture to focus $\frac{1}{6}$ to $\frac{1}{7}$) full aperture is invariably employed. Among specially bright surroundings, for instance, in photographing on the water, or in very clear weather with white clouds, which considerably increases the brightness, as has already been mentioned, a smaller stop can be used. When using objectives which, like the Anti-planet and many Euryscopes, let more light pass through (ratio of

aperture to focus $\frac{1}{4}$ to $\frac{1}{5}$), a smaller stop may be used in a good light.

In order to make sure that the object to be taken is included by the plate, either a detective camera fitted with a view-finder (see p. 44) is used, or the operator looks without a finder along the upper corner of the apparatus at the object.

Gelatine bromide of silver plates are used exclusively for instantaneous work; collodion plates are not sensitive enough.

A special rapid hydrokinone developer described on p. 83 is suited to the development of instantaneous photographs, as are also eikonogen, rodinal and metol.

IV.

THE MAKING OF NEGATIVES.

Among the best-known negative processes the following are conspicuous :—

1. *The process of gelatine bromide of silver dry plates.*
2. *The wet collodion process.*
3. *The collodion emulsion process.*

The two latter are used exclusively in making reproductions; that is, in studios which are occupied in photographing drawings and paintings, etc.; in portraiture and landscape work they are almost entirely superseded by the more convenient gelatine processes.

The reason of this is the much greater sensitiveness of the latter. The sensitiveness of gelatine plates is nearly 10 times as great as that of wet collodion plates, and 30 or 40 times as great as that of collodion emulsion plates.

Gelatine plates can be bought ready for use. They can be kept for a long time, and may also be left undeveloped for some time after exposure. Collodion plates must be prepared only shortly before use, and not left long before development.

Of the processes mentioned, the gelatine process is almost exclusively used by amateurs on account of its simplicity, and it will therefore be first described here.

1. Work with Ready-made Bromide of Silver Gelatine Dry Plates.

Gelatine plates of good quality by many makers may be obtained commercially. Their preparation at home needs much practice and care, and is not at all to be recommended.

The preparation of dry plates is effected in the following way:—

A solution of gelatine is placed in warm water with potassium or ammonium bromide and nitrate of silver.

Then by double decomposition bromide of silver and ammonium or potassium nitrate are formed. The bromide of silver remains suspended in the gelatine solution in a finely divided condition, and forms the so-called bromide of silver gelatine emulsion. By boiling the latter, or by treating it with ammonia, the sensitiveness of the bromide of silver is considerably increased.

The emulsion is then cooled until it becomes quite stiff, then is cut up into pieces, and washed for a long time in cold water to get rid of the potassium and ammonium nitrates.

When the washing is finished, the emulsion is liquefied by warmth, and (generally by means of a coating machine) spread upon glass plates and dried. After drying, the plates are ready for use.

They will keep for a very long time if protected from light and kept dry.

PUTTING THE PLATES INTO THE DARK SLIDE.

The plates are taken out of their packing in *red light* (see p. 48), and brushed over with a clean soft camel-hair pencil to remove all particles of dust. Then the plates are laid in the dark slide with the *dull side* (that is, the film side—the side covered with

sensitive substance) *turned towards the shutter of the dark slide.*

The sides can also be distinguished in the dark by the touch; the finger-nail moves without hindrance over the glass side, but not over the film.

The plate must be held by the corner, and care must be taken not to handle the film unnecessarily, as marks are easily made by a moist finger.

The plates ought not to be exposed even to red light too long, as they easily fog; it is usual to put them in their places by subdued light.

FOCUSSING.

Point the apparatus towards the object to be taken, remove the cap from the objective and also the stop, and screw up the focussing screen or the objective board of an apparatus with fixed screen, until the part of the picture in the middle of the screen is sharp.

To cut off disturbing side-lights while focussing a dark cloth, called the "focussing cloth," is thrown over the head and the back part of the camera.

A *focussing glass* can be used to lighten the work by magnifying the size of the image on the screen, and by that means allowing any blurring to be more easily seen.

This magnifying glass must first be focussed to the thickness of the screen. This is done by making a pencil cross on the back of the latter, and moving the glass in and out till it appears sharp.

When the focussing is done a stop is inserted, which is requisite to obtain greater sharpness of image, and the objective is covered with the cap. The smaller the stop the sharper the picture will be. In a good light small stops may be used on objects at rest (landscapes, etc.), when a longer exposure does not

matter. The danger of over-exposure, also, is less with small stops.* In portraiture and instantaneous work the use of small stops must be dispensed with on account of the longer exposure required, and it is necessary to be satisfied with an image less sharp.

THE EXPOSURE.

When the focussing is completed, carefully open the screen of the camera *without shaking it at all*, slip the dark slide in, and after seeing that the stop is in and the lens capped, raise the shutter of the dark slide. If working in the open air, throw a dark cloth over the apparatus before opening the dark slide, to prevent the entrance of light through any place in the camera that may not be quite light-tight.

The cap is then removed *without shaking the apparatus*, and an *exposure* of requisite length made.

The determination of the time of exposure is a matter of experience, and can only be learnt by long practice. It depends

1. On the amount of light transmitted by the objective used.
2. On the size of the stop.
3. On the sensitiveness of the plate.
4. On the time of day and season.
5. On the weather.
6. On the brightness of the object to be taken.

Tables of exposure give a general idea of the time required (see next page).

These tables give the time required for plates of medium sensitiveness on a fine bright sunny day.

The great variations in the light at different times of the day and season are not taken into account in them; yet these variations are so important that they cannot be neglected. The following tables will assist

* The author always uses the smallest stop for landscapes, except in windy weather.

in deciding this point: 0 in them stands for midday; 1 stands for 1 hour distant from midday (either 11 A.M. or 1 P.M.) The other numbers explain themselves.

STRENGTH OF LIGHT IN THE OPEN AIR WITH BLUE SKY FOR PLACES OF THE LATITUDE OF BERLIN AT DIFFERENT SEASONS AND TIMES OF DAY.

	0 h.	1 h.	2 h.	3 h.	4 h.	5 h.	6 h.	7 h.	8 h.
21. Jan. / 21. Nov.	$\frac{3}{5}$	$\frac{3}{5}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{14}$				
21. Feb. / 21. Oct.	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{14}$			
21. Mar. / 21. Sept.	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{3}{5}$	$\frac{1}{3}$	$\frac{1}{14}$		
21. April. / 21. Aug.	1	1	1	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{2}{3}$	$\frac{2}{5}$	$\frac{1}{14}$	
21. May. / 21. July.	1	1	1	1	$\frac{7}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{2}{7}$	$\frac{1}{14}$
21. June. / 21. Dec.	1 / $\frac{1}{2}$	1 / $\frac{1}{2}$	1 / $\frac{2}{5}$	1	$\frac{7}{8}$	3	$\frac{3}{5}$	$\frac{1}{3}$	$\frac{1}{6}$

BURTON'S EXPOSURE TABLES.

Aperture in proportion to focus.	Sea and Sky.	Open Landscape.	Under trees up to		Bright interiors from		Dark interiors up to		Portraits in open air clear light.	Indoor portraits.	
	Sec.	Sec.	M.	Sec.	M.	Sec.	Hrs.	M.	Sec.	M.	Sec.
F/4*	$\frac{1}{600}$	$\frac{1}{500}$		10		10		2	$\frac{1}{6}$		4
F/5	$\frac{1}{800}$	$\frac{1}{250}$		20		20		4	$\frac{1}{3}$		8
F/8	$\frac{1}{400}$	$1\frac{1}{2}$		40		40		8	$2\frac{1}{3}$		16
F/12	$\frac{1}{200}$	$\frac{1}{6}$	1	20	1	20		16	$1\frac{1}{3}$		32
F/16	$\frac{1}{100}$	$\frac{1}{3}$	2	40	2	40		32	$2\frac{1}{3}$	1	4
F/22	$\frac{1}{50}$	$\frac{2}{3}$	5	20	5	20	1	4	$5\frac{1}{3}$	2	8
F/32	$\frac{2}{50}$	$1\frac{1}{3}$	10	40	10	40	2	8	$10\frac{1}{2}$	$4\frac{1}{4}$	
F/45	$\frac{4}{50}$	$2\frac{2}{3}$	21		21		$4\frac{1}{4}$		21	$8\frac{1}{2}$	
F/64	$1\frac{1}{2}$	$5\frac{1}{2}$	42		42		$8\frac{1}{2}$		42	17	

* The expression F/4 means that the objective is so stopped that the aperture is equal to $\frac{1}{4}$ the focus.

Consequently you must expose at noon on Dec. 21st, in fine weather, for instance, about three times as long as on June 21st, at the same time.

Of course the above numbers only hold good in fine unclouded weather.

Immense differences in brightness are caused by clouds. White clouds sometimes increase it enormously, as they act in some measure like a great reflecting screen.

Dark storm-clouds can reduce the light to $\frac{1}{50}$ or even less of its normal brightness.

It is advisable for beginners to make out notes of their exposures after the following scheme, and to expose them too much rather than too little, as over-exposure is more easily remedied by suitable development than under-exposure.

Date.	Time of day.	Weather.	Object.	Lens.	Stop.	Brand of plate.	Exposure.	Developer.	Result.
10/4	4 P.M.	Clear, cloudless	Brightly lighted landscape	Steinheil's Aplanatic	Smallest	Perutz	2 sec.	Hydrokinone	Rightly exposed
15/4	3 P.M.	Blue sky, white clouds	Well lighted building	,,	,,	,,	5 sec.	,,	Over-exposed; remedied by adding potass. bromide

DIRECTIONS FOR MAKING UP DEVELOPER.

No trace of the image is visible upon the exposed plate; this must be brought out, "developed," by treatment with some reducing solution, the so-called developer.

The process depends upon the fact that the bromide of silver particles, in the plate which have been exposed, are more easily converted by the reducing solution into metallic silver than those which have not been exposed. By too long a development, or by using too strong a developer to begin with, the unexposed bromide of silver is also changed. This is the reason why development can only be carried on to a certain point.

A distinction is made between acid developers like oxalate of iron and alkaline ones like pyrogallic acid, hydrokinone, eikonogen, para-amidophenol, metol. Experienced workers can get good results with all developers; beginners do best to begin to work with one tried developer, and afterwards try the others when they have fully mastered the process.

Generally, an *alkaline* developer is preferable, as the acid (oxalate of iron) easily leaves marks if not used with almost troublesome care. The author uses hydrokinone and pyrogallol almost exclusively; the first especially for landscapes. Hydrokinone develops very slowly, and allows great latitude in time of exposure, so may be recommended for beginners. For quicker work pyrogallic acid is to be recommended.

In making up solutions the following point is to be noted: the substances are to be dissolved singly *one after the other* in the given order, not all at once.

Solution II. of the oxalate developer as well as Solution I. of the pyrogallic, hydrokinone, and eikonogen developers oxidise easily, and must be kept in well-corked bottles. Pyrogallic, hydrokinone, eikonogen, para-amidophenol and metol solutions are best kept in the dark. The filtration of these solutions is not to be recommended, as it leads unavoidably to their contact with the air, which oxidises them and lessens their efficacy. The developing substances are in most cases freely soluble, or else a deposit sinks to

the bottom after standing a short time, and the developer becomes clear.

The author keeps the solutions mentioned as being easily oxidised in a bottle, described on p. 53, under vaseline oil; a colourless, scentless oil, which is not turned rancid by the air or by alkali. A few developers which would even spoil if kept in ordinary bottles can be preserved in this way, because the oil perfectly protects it from contact with the air.

Of the numberless more or less useful developers, whose number is almost daily increased, the directions for a few useful and thoroughly tried ones are given here.

A. Oxalate of Iron Developer.

Sol. I.	Potassium oxalate (potassium neutralised with oxalic acid)	200 grms. =	3086 grs.*
	Distilled water† ...	800 c.c. =	28 oz.
,, II.	Ferrous sulphate ...	100 grms. =	1543 grs.
	Distilled water ...	300 c.c. =	10 ozs.
	Concentrated sulphuric acid	5 drops	
,, III.	Potassium bromide	10 grms. =	154 grs.
	Distilled water ...	100 c.c. =	3 ozs.

Solutions I. and III. may be kept for an unlimited time.

Solution II. is best kept in a well-corked bottle in daylight, and then keeps a long time. In the dark it soon becomes yellow, and is then useless.

For use, mix 60 parts Solution I. with 20 parts Solution II. shortly before needing it, and add 1 or 2

* 437·5 grs. = 1 oz. avoirdupois.—*Translator.*

The values given in this and the following tables are only approximately correct.—*Translator.*

† If ordinary water is used, in consequence of its chalky contents a white precipitate of oxalate of calcium is formed by the oxalic acid.

drops of Solution III., or more with plates that easily fog. The iron solution must be poured into the oxalic of potash solution, not *vice versâ*, or else a sandy precipitate of ferrous oxalate will be formed. This also appears if more iron is used than the quantity given above.

The above is the normal proportion of mixture for rightly exposed plates. Less iron and more potassium bromide must be used with over-exposed plates. If over-exposure is suspected, it is best to follow this method: Measure up Solutions I. and II. separately, add to I. only a small part of II. at first, and begin to develop. If the image appears very slowly, so that it was not over-exposed, add the rest of the iron solution by degrees; but if the plate was over-exposed, and the image appears very quickly, then add a few drops of potassium bromide, and continue to the end with this weak developer. Old developer also (that is, that which has been already used) may be employed upon over-exposed plates with advantage.

Plates which have had a very short exposure (as in instantaneous work) often have a preliminary bath at the beginning of their development. The plate is laid before development for one minute in a solution of 15 grs. hyposulphite of soda in 35 ozs. of water; it is then allowed to drain, and developed without washing. The image appears very quickly.

By the use of this preliminary bath upon under-exposed plates "harshness," that is, too great a contrast, can be prevented from occurring in the negative. The addition of from 10 to 40 drops of a one-hundredth solution of hyposulphite of soda to 60 parts of the developer is not to be recommended. This quantity easily causes a mirror-like deposit of silver upon the plate, the so-called "silver fog." Scrupulous cleanliness of the fingers must be observed in developing with oxalate of iron. The slightest

trace of fixing solution clinging to the fingers would cause stains upon the plate at a touch. Black marks can always be easily made by a moist finger, and so the plate should always be held by the edges, and care should be taken not to touch the film.

Dishes which have been used with other developers (especially pyrogallol) must only be used with the iron developer after the most careful washing, for traces of pyrogallic acid in the developer colours the image black.

B. Pyrogallol Developer.

1. Pyro. and Soda Developer.

Sol. I.	Crystallised sulphite of soda	100 grms.	=	1543 grs.
	Distilled water ...	500 c.c.	=	17 ozs.
	Concentrated sulphuric acid	8 drops		
	Pyrogallic acid ...	14 grms.	=	215 grs.
„ II.	Crystallised carbonate of sodium (soda) ...	50 grms.	=	772 „
	Distilled water ...	1,000 c.c.	=	35 ozs.

In preparing Solution I. take care that the pyrogallic acid is put in when the sulphite of soda is fully dissolved. The last must be kept in well-corked bottles, as in air it decomposes; that is to say, it loses its crystalline form, and in great part is oxidised into sulphate of soda; it then becomes a fine white powder. Decomposed sulphite of soda is useless, as it is no longer a preservative, and strongly retards development. Solution I. may be kept for a long time, and Solution II. without limit.

For use, mix 20 parts Solution I. with 40 parts Solution II., and add to it 2 or 3 drops potassium bromide. In over-exposure you may increase the bromide or

take less of Solution II.; for under-exposure leave out the bromide, provided that the plates used are free from fog. It is advisable to begin development with already used developer.

For plates which give great contrast the developer may be diluted with from half to an equal quantity of water to obtain a soft negative.

2. PYRO. AND POTASH DEVELOPER.

If in the former instructions carbonate of potassium (potash) is substituted for carbonate of soda a developer of energetic action is obtained. It is especially suited to the development of instantaneous photographs; soda is preferable in other cases.

The following developer is also much used :—

Sol. I.	Crystallised sulphite of soda	100 grms. =	1543 grs.
	Distilled water ...	400 c.c. =	14 ozs.
	Concentrated sulphuric acid	20 drops	
	Pyrogallic acid ...	40 grms. =	617 grs.
„ II.	Carbonate of potash	180 „ =	2777 „
	Crystallised sulphite of soda	50 „ =	771 „
	Distilled water ...	400 c.c. =	14 ozs.
„ III.	Citrate of potash ...	10 grms. =	154 grs.
	Distilled water ...	100 c.c. =	3 ozs.

For use, mix 3 parts Solution I. with 3 parts Solution II., and 100 parts distilled water. The addition of Solution III., by drops acts as a work retarder. The addition of potassium bromide $\frac{1}{10}$ solution retards development more strongly. For over-exposure, dilute the developer with water, or add more bromide solution to it.

C. Hydrokinone Developer.

1. HYDROKINONE WITH POTASH.

Sol. I. Crystallised sulphite of soda ... ... 40 grms. = 617 grs.
Distilled water ... 600 c.c. = 21 ozs.
Hydrokinone ... 6 grms. = 92 grs.
„ II. Carbonate of potash * 50 to 75 grms. = 771 to 1157 „
Water ... ... 600 grms. = 21 ozs.

In place of the carbonate of potash carbonate of soda can be used, from an equal quantity up to double. The developer acts more quickly, however, with potash.

For use, mix equal parts of Solution I. and II., and add some drops of a one-tenth solution of potassium bromide (1 in 10 or 10%). Four drops are enough for 50 parts of developer.

Freshly mixed developer acts too strongly without potassium bromide. Instead of using the bromide, the developer can with advantage be mixed with some that has been already used. A small *addition of yellow prussiate of potash* to the developer makes clearer work, and hastens development. One drop of a one-tenth solution may be put in 10 parts of developer.

The developer, when mixed, may be kept for a week in well-corked bottles, but it is best to mix it shortly before use, as it acts more energetically while fresh.

Hydrokinone developer allows great latitude as to time of exposure; even very much over-exposed plates can be developed by it without fog.

Plates whose exposure is doubtful should be begun with old developer, or, in the absence of this, with fresh developer containing potassium bromide. If the

* The more carbonate of potash used the quicker the development proceeds, but too much of it causes frilling. The author generally uses 50 grms.

plate was over-exposed the image will come up quite fast enough, and full of detail in this weak developer; if it does not, this developer is poured off wholly or partially, and fresh substituted.

In developing the negatives of line-drawings, as well as with plates which do not give sufficiently vigorous negatives with the former developer, it is advisable to use a larger quantity of hydrokinone. In this case 10 grms. may be used instead of 6 grms.

2. CONCENTRATED HYDROKINONE DEVELOPER.

For the purpose of travelling, concentrated hydrokinone developer can be kept in stock. It lasts a long time if well corked. It is made as follows :—

Distilled water	150 c.c.	=	5 ozs.
Crystallised sulphite of soda	40 grms.	=	617 grs.
Hydrokinone	6 „	=	92 „
Carbonate of potash	50 „	=	771 „

The sulphite of soda is first dissolved, then the hydrokinone, and (after both are quite dissolved) the carbonate of potash. To facilitate the solution of the salt the bottle may be put into a vessel of warm water.

For use, the concentrated developer is diluted with from 4 to 6 times its quantity of water, and forms the same developer which was given under the first head. Distilled water is generally to be recommended for dilution, but is not absolutely necessary. With photographs of doubtful exposure it is well to begin the development with the diluted solution, and gradually to strengthen it by the addition of the concentrated.

All the above hydrokinone developers must have a temperature of 16° *or* 17° *C.* (61° *F.*) *at least. At a lower temperature the development proceeds extremely slowly.*

3. RAPID HYDROKINONE DEVELOPER.

Development goes on more slowly with the hydrokinone developer given above than with iron or pyro. This delay is in most cases a great advantage, especially with plates of doubtful exposure, since it is easy to perceive that the development can be watched better than when it proceeds very quickly.

For certain purposes, for instance, in the hasty work of portrait studios, a quicker method is desired. This is obtained by the *addition of caustic potash or caustic soda* to the developer given above. The development then proceeds with extreme rapidity.

All the developers hereafter described containing caustic soda or potash have the disadvantage of acting very strongly upon the gelatine film of the plate, so that it easily leaves the glass or "frills"; that is, becomes detached round the edges. These faults can, however, be prevented by suitable means to be further described, but in no other way with any certainty.

Some plate-makers give their plates a substratum of chromatic gelatine; the film of these plates adheres much more firmly to the glass; but plates are also made with no substratum, which seldom show any tendency towards frilling.

According to Baltin, a very good, quick working developer is obtained by mixing 100 parts of one of the hydrokinone developers described above with 5 parts of a solution of 617 grs. of caustic potash in 4 ozs. of water.

The developed plate should be laid without washing in a cold saturated solution of potassium citrate for 5 or 10 minutes, in case it has a tendency to frill, and is then washed and fixed.

By adding ferro-cyanide of potassium to the rapid developer fog is prevented. A good recipe (by Lainer) for making such a developer is as follows:—

Sol. I.	Distilled water ...	900 c.c. =	32 ozs.
	Crystallised sulphite of soda	40 grs. =	617 grs.
	Ferro-cyanide of potassium	120 „ =	1851 „
	Hydrokinone... ...	10 „ =	154 „
„ II.	Caustic soda	100 „ =	1543 „
	Distilled water ...	200 c.c. =	7 ozs.

For use, mix 60 parts Solution I. with 6 parts Solution II., and add a few drops of a one-tenth solution of potassium bromide. The image appears in from 3 to 5 seconds, and is completely developed after 30 or 40 seconds.

Many sorts of plates fog with this developer; in this case use more potassium bromide, and dilute the developer with an equal volume of water. The development will then proceed more slowly, but quite quickly enough.

In plates such as Perutz made, with but little gelatine, it is always advisable to use diluted developer, as if it is too strong the development will be too quick.

The following concentrated rapid hydrokinone developer is much to be recommended, especially for travelling:—

4. CONCENTRATED RAPID HYDROKINONE DEVELOPER.

A. Dissolve 469 grs. sulphite of soda in 4 ozs. of water, and then at a high temperature 154 grs. hydrokinone, and further 385 grs. ferro-cyanide of potassium in 4 ozs. of water. The solutions are mixed. B. Further, dissolve 771 grs. caustic potash in 4 ozs. of water, or 469 grs. caustic soda in 3 ozs. of water.

A. and B. are then mixed, and put into a well-corked bottle, preferably with a glass * or rubber stopper, as

* The stopper must often be greased, or else it easily sticks fast in the neck of the bottle.

caustic potash and soda act strongly on cork. The concentrated developer will keep for a long time.

For use, 10 parts of it are diluted with 30 parts of distilled water (ordinary water may be used if necessary) for rapid, with 60 parts for slow, development.

Of course the addition of a few drops of potassium bromide is necessary to fresh developer. The author generally uses developer even more diluted, namely, 5 parts (concentrated) to 50 parts of water. Even in this diluted state it acts faster than that given above without caustic potash.

Glass or porcelain dishes should be used with the rapid developer; *papier-mâché* is not so good, as the varnish is soon destroyed by the caustic potash.

The rapid developer is especially suited to instantaneous exposures.

D. Eikonogen Developer.

1. PORTRAITURE AND LANDSCAPE.

Sol. I.	Crystallised sulphite of soda	100 grms.	= 1543 grs.
	Distilled water ...	1,500 c.c.	= 53 ozs.
	Concentrated sulphuric acid	8 drops	
	Eikonogen... ...	25 grms.	= 385 grs.
„ II.	Crystallised carbonate of soda	150 „	= 2314 „
	Distilled water ...	1000 c.c.	= 35 ozs.

For use mix three parts of Solution I. with one part of Solution II., and add a few drops of a one-tenth solution of potassium bromide.

2. INSTANTANEOUS PHOTOGRAPHS.

The first recipe holds good, with the difference that the crystallised carbonate of soda is mixed with an equal quantity of carbonate of potash (white potash).

3. FOR VERY QUICK INSTANTANEOUS PHOTOGRAPHS, AND TO INVIGORATE DEVELOPERS I. AND II. FOR UNDER-EXPOSURE.

Sulphite of soda	...	100 grms.	= 1543 grs.
Carbonate of potash	...	40 „	= 617 „
Eikonogen	... ...	20 „	= 308 „

dissolved in 21 ozs. of boiled distilled water.

Eikonogen developers do not give so much latitude of exposure as hydrokinone. In general, some practice is requisite for working with eikonogen, as flat pictures can easily be made by wrong exposure. The image appears very quickly, but only becomes vigorous after long development; but this developer is just suited to instantaneous photographs.

With time exposures it is of advantage to begin with old developer, or that containing potassium bromide, to equalise any possible over-exposure.

The preparation of a concentrated eikonogen developer is scarcely possible, as eikonogen is only soluble with some difficulty. In place of this eikonogen cartridges are on sale for use in travelling. They are paper cases, which contain the constituents of the developer weighed up in the form of powder.

For use, the contents of a cartridge are dissolved in 7 to 10 ozs. of water, and a developer ready for use is obtained in a short time.

E. Para-amidophenol Developer.

Under the name of "Rodinal" a concentrated para-amidophenol developer, which only needs dilution with water to be ready for use, has been introduced into commerce by the Aktiengesellschaft für Anilinfabrikation.

Rodinal works very quickly, and is especially excellent for instantaneous photographs, but after a little

practice can be used with great advantage for time-exposures.

The dilution of the developer is different according to the kind of plate and the desired result. With *slight dilution* (1 to 10 or 20), *rodinal develops quickly and with great contrast; when much diluted* (1 in 30 or 40) *it is slow and soft. It follows that rodinal must be used diluted for vigorous pictures, concentrated for soft ones.*

If slower development is desired with concentrated rodinal (1 in 10 or 20), *a one-tenth solution of potassium bromide may be confidently added in large quantity.* The addition of potassium bromide decreases the *speed of development* without influencing *the character of the negative* as much as with other alkaline developers.

The developing action of rodinal is very considerable, so that the faults of over-exposure may be met at once. An over-exposed plate, developed with a one-thirtieth solution of rodinal, gives a negative rich in detail, but thin. Over-exposed plates may with advantage be treated with stronger ($\frac{1}{20}$ to $\frac{1}{15}$) rodinal, with the addition of a large quantity of potassium bromide. In this way it is possible to get vigorous and well-contrasted negatives from over-exposed plates.

In under-exposure concentrated rodinal would give too great contrasts. The high lights are over-developed before the detail has had time to come out in the dark parts. Under-exposed plates should be developed with a diluted solution of rodinal, 1 in 30 or 40. The development then lasts a long time, but a harmonious negation is obtained, which will print and can be intensified.

The fact that concentrated rodinal gives a contrasted picture, and diluted rodinal a softer one, gives us a useful means of remedying faulty exposure. Pictures taken in glaring light (for instance, street

scenes in sunlight) are best developed with diluted rodinal ($\frac{1}{30}$ or $\frac{1}{40}$ solution); while those taken in dim light (for instance, landscapes in gloomy weather) give a better result with concentrated rodinal ($\frac{1}{20}$ to $\frac{1}{15}$ solution), to which potassium bromide has been added.

From these considerations it follows that it is sometimes judicious to begin developing with a weak solution, and afterwards to strengthen it, if needful, by a mixture of rodinal and potassium bromide (for instance, a mixture of 1 oz. rodinal solution, with a solution of 154 grs. bromide in 1 oz. of water).

The concentrated solution of rodinal should be kept in a well-corked bottle, or under mineral oil (see p. 53). The diluted solution turns brown after a few days, and acts less strongly than fresh. If it is desired to keep the diluted solution for a longer time a 10% solution of crystallised sulphite of soda should be used to dilute it in place of water.

A developer resembling rodinal is obtained, according to the following instructions by Dr. Andressen.

In 4 ozs. of water 469 grs. of meta-bisulphite of potassium, and then 154 grs. chloride of para-amidophenol are dissolved. Stir into this a cold saturated solution of caustic soda until the separated para-amidophenol is dissolved again. A surplus of caustic soda is to be avoided as far as possible.

For use, this developer is diluted with water like rodinal.

F. Metol Developer.

Metol is one of the most powerful developers, and is especially suited for instantaneous photographs, when used with carbonate of potash or soda. Metol, which is equal in strength to the rapid hydrokinone developer (see p. 82), surpasses it in the great advantage of containing no caustic potash or caustic soda, which acts so strongly upon the film of the plate and

the fingers of the operator. Professor Eder gives the following instructions for metol :—

1. METOL WITH POTASH.

Sol. I.	Distilled water ...	1000 c.c.	= 35 ozs.
	Neutral sulphite of soda	100 grms.	= 1543 grs.
	Metol	10 „	= 154 „
„ II.	Water	1000 c.c.	= 35 ozs.
	Carbonate of potash	100 grms.	= 1543 grs.

For use, mix 60 parts Solution I. with 20 parts Solution II.

It is advantageous to add a few drops of 10% *solution of potassium bromide, otherwise the developer acts too quickly and strongly.* A considerable amount of bromide may be added without fear of causing harshness.

This developer can be used at once, but keeps for a week in well-secured bottles.

The image appears almost instantaneously upon a normally exposed plate with this developer. It at first appears thin and grey, but continually gains density, and the development is, on an average, finished in two or three minutes. Negatives show no tendency to harshness in a development lasting longer.

For a *longer development*, if a very soft picture is desired, mixture with a solution containing more water and less carbonate of potash is advisable; for instance, 60 parts Solution I., 10 parts Solution II., and 20 parts water.

The effect of the carbonate of potash is increased by this; so that the development proceeds more quickly, and the high lights of the picture soon attain density.

For those plates or films which, with the usual developer, take too long to gain the requisite density, 60 parts of Solution I. may be mixed with 30 or 40 of Solution II.

Metol developer loses its efficiency only slightly when several plates are developed, and gradually assumes a brownish colour; old metol developer is naturally weak, and therefore suitable for developing over-exposed plates.

2. METOL WITH SODA.

Sol. I.	Distilled water ...	1000 c.c.	=	35 ozs.
	Crystallised sulphite of soda	100 grms.	=	1543 grs.
	Metol	10 „	=	154 „
„ II.	Distilled water ...	1000 c.c.	=	35 ozs.
	Crystallised carbonate of soda	100 grms.	=	1543 grs.

For use, mix equal parts of the solutions, and add a few drops of a 10% solution of potassium bromide.

If the developer is to act more gently the mixture may be diluted with half as much water, or 1 part of Solution I. may be mixed with $\frac{1}{2}$ to $\frac{1}{6}$ of Solution II.

Metol works more slowly with soda than with potash, but is always quite quick enough.

G. MIXED DEVELOPERS.

Many mixtures of pyrogallic acid, hydrokinone and eikonogen are also recommended, and are on sale in concentrated forms. To these belong the so-called "Crystals" of commerce, which consist of hydrokinone, eikonogen, ferro-cyanide of potassium, and caustic potash. The hydrokinone rapid developer acts just as well as these.

A very useful recipe for a mixed hydrokinone-eikonogen developer is the following:—

Sol. I.	Boiling distilled water	900 c.c.	=	32 ozs.
	Crystallised sulphite of soda	100 grms.	=	1543 grs.
	Eikonogen ...	16 „	=	247 „
	Hydrokinone ...	4 „	=	62 „

Sol. II. Distilled water ... 200 c.c. = 7 ozs.
Carbonate of potash 40 grms. = 617 grs.

For development mix
180 parts of Solution I.
40 „ „ II.
3 drops 10% potassium bromide solution
15 „ 10% solution of ferro-cyanide of potassium.

The developer can be used in many ways. It is best to use equal parts of old and fresh developer; in default of old developer add a little more potassium bromide.

Development and Fixing.

*The exposed plate, upon which, as has been mentioned, no trace of an image is visible, is taken out of the dark slide by red light in the dark room, and laid film upwards in a papier-mâché glass or porcelain dish. The developer is poured over the plate in a shower, so that it at once completely covers it.** Forty c.c. of developer will suffice for a plate 13 × 18 c.c. (= 1½ oz., to a 5 × 7 plate). In rocking the dish care must be taken that the plate always remains completely covered. It must not be exposed unnecessarily to the red light, as even this has in time some effect upon the plate. It is best to work in shade, or to cover the dish with a cardboard lid. After some time, which depends upon the length of the exposure as well as the quality of the plate and the developer used, the image will make its appearance. The brightest parts of the object appear first, for instance, collars and cuffs in portraits; then the half-tones appear, and last of all the details in the deepest shadows. *If even in a long development the details in the dark parts do not appear, the plate*

* The beginner would do well to use somewhat more developer than the amount given above, while the experienced operator will need less.

is "under-exposed." In this case fresh developer without bromide should be tried, to bring out as much as possible. *If the picture appears quickly and without vigour, and soon fades as the plate becomes grey all over, except the unexposed places on the edges, the plate has been exposed too long, or over-exposed.** Over-exposed plates can be saved by the addition of much potassium bromide, or by beginning with old or diluted developer. More about the development of over-exposed plates is to be found under the heads of the instructions for development.

At first the appearance of the image can best be observed by looking at it; later on, when it is too dark for this, by looking through it.

It is important to know the right moment at which to stop the development. *The image must appear darker to look through than the finished negative does, because it becomes transparent in the fixing bath.* Absolute instructions as to the duration of development cannot be given, because every sort of plate is different; the aim is reached by experience alone.

The often repeated rule, "Develop until the image is visible at the back of the plate," is not at all safe. Thickly-coated plates would be much over-developed if they were continued so long. Beginners often have a disposition to take the plates out of the developer too soon. *As soon as the image appears vigorous enough on looking through, the plate should be washed under a tap for about a minute.* In travelling, when a tap is not generally available, the plate may be dipped into a bucket of water several times. It is then laid, with film side uppermost, in the "fixing-bath," for which instructions are given below.

This fixing-bath dissolves whatever bromide of

* It is well for beginners to take a rightly exposed plate, an over-exposed, and an under-exposed one, so as to form an idea of their procedure.

silver still remains in the plate, while the metallic silver of which the image is composed remains behind. *It is fixed as soon as all the white bromide of silver has disappeared from the back.* The plate is, however, left in the fixing-bath for some time after this is observed. By the solution of the bromide of silver in the hyposulphite of soda a double salt is formed—hyposulphite of silver and hyposulphite of soda—which is very easily soluble in the fixing solution, but in water only with much difficulty. This, after an insufficient fixing, remains in the film, and is often not entirely removed by the subsequent washing (which, however, is indispensably necessary), and in a short time leaves yellow marks upon the plate. After fixing the plate is not sensitive to light.

Instructions for the Fixing-bath.

1. Acid fixing-bath.

Hyposulphite of soda	... 100 grms.	= 1543 grs.
Water (it is not absolutely necessary to use distilled)	... 500 c.c.	= 17 ozs.
Acid sulphite of soda lye 25 to 50	„	= 1 to 2 „

That is, a solution of the acid sulphite of soda which is on sale.

Instead of the last a 25% of sulphite of soda may be used, which is carefully mixed with so much sulphuric or hydrochloric acid that the smell of sulphurous acid arises. A surplus of acid must be avoided, or sulphur would be precipitated in the fixing-bath. It is safer to use a weighed quantity of a solid acid like tartaric acid. Twenty parts of 50% tartaric acid solution are necessary to 60 parts 25% solution of sulphite of soda, according to Lainer. The addition of acid lye to the fixing-bath is not absolutely necessary, but very advisable. The bath always remains clear, and any yellow stain on the

plate originated in development, as by pyrogallic acid, is completely removed. By repeated additions of acid the bath can be used for a long time, until it fixes too slowly.

Fixing-baths without acids soon become brown, and must then be thrown away.

2. MIXED ALUM AND FIXING-BATHS.

Many sorts of plates blister in fixing, or "frill," the film becoming detached round the edges. Such plates should (according to Lainer) be fixed in an alum bath.

Mix together

Saturated solution of alum	...	1000 parts
„ „ sulphite of soda		200 to 300 „
„ „ hyposulphite „		1000 to 1200 „

The plates must be well washed before fixing. This bath acts more slowly than the acid bath given above.

WASHING AND DRYING THE PLATES.

The fixed plates must be well washed to remove the hypo., which soon causes the negative to fade if it is left in the plate. It should be washed in running water* for about half an hour.

If there is no running water available the plate should be laid, film side uppermost, in a dish with water, which must often be changed. This washing must be carried on with especial care if the plates are to be intensified, as stains often appear then.

The washed plates are put in a rack to dry (see p. 55). Any impurities on the back of the plate should be removed, *before* drying, with a stiff brush. *The drying should not be accelerated by heat, or the gelatine film will easily melt.* If speedy drying is desired the

* For washing arrangements necessary see p. 53.

plate (from which most of the water has run) should be dipped into strong alcohol (95 or 96%) for 5 to 10 minutes; this removes the water from the film. The negative is perfectly dry 10 minutes after this alcohol bath.

THE REDUCTION OF PLATES.

Plates which are too dense, and would take too long to print, must be reduced. Farmer's red prussiate of potash reducer is most suitable for the work.

1. REDUCER WITH FERRI-CYANIDE OF POTASH.

Sol. I.	Hyposulphite of soda	100 grms. =	1543 grs.
	Water	500 c.c. =	17 ozs.
„ II.	Ferri-cyanide of potassium	10 grms. =	154 grs.
	Distilled water ...	50 c.c. =	1½ oz.

Both solutions will keep; the second must be kept in a brown bottle, or in the dark.

For use, 100 parts of Solution I. are mixed with 5 parts Solution II.,* and the plate laid in it immediately after fixing (washing is unnecessary), until it is sufficiently reduced, and *then washed for half an hour*. Plates that have been dried should be laid for some time in water before reduction, so that the solution is absorbed equally. *If certain parts only of the negative are to be reduced* the excessive water should be removed from the wet plate with blotting paper, so that the film is only moist. The reducer is applied to the places to be treated with a camel's hair-pencil. It is well to use a weaker reducer for this, say 100 parts Solution I. and 2 parts Solution II.

Plates developed with iron easily assume a faint blue colour in this reducer if the iron has not been

* The reducer keeps only a short time when mixed; it is useless as soon as it turns blue or colourless.

well washed out. If this fault has occurred, the following reducer of Belitzki may be used:—

2. REDUCTION WITH FERRIC OXALATE.

Distilled water ...	... 300 c.c.	= 11 ozs.
Potassic ferric oxalate ...	15 grms.	= 231 grs.
Crystallised sulphite of soda	15 c.c.	= 231 „

Put 77 grs. of oxalic acid into this solution, and shake until the red solution turns green. Pour off from the undissolved oxalic acid, and put in 1157 grs. hyposulphite of soda. After solution has taken place it is filtered. The solution must be put in the dark or in a brown bottle; it will then keep for a long time. The reducer can be used after fixing without the previous washing.

3. MECHANICAL REDUCTION.

Particular parts of dry negatives which are too dark can be mechanically reduced by careful rubbing with a linen cloth, moistened with 95% alcohol.

INTENSIFICATION OF PLATES.*

Plates which by reason of faulty exposure or development are too thin, and consequently give prints with no contrast, must be intensified.† Fogged plates must be first reduced until the fog has quite disappeared.

Before intensification every trace of hypo. must be carefully washed away, or else failure in intensification is unavoidable.

* It is usual only to intensify plates when it is a *necessity*. Try to get sufficiently vigorous negatives as much as possible by development.

† For the sake of beginners it may be mentioned that only the visible parts of negatives are strengthened by intensification. Consequently if the shadows are without detail, intensification is useless. The false idea that more details are brought out by intensification is widespread.

1. CHLORIDE OF MERCURY INTENSIFIER.

Sol. I.	Bi-chloride of mercury	2 grms. =	31 grs.
	Distilled water ...	100 c.c. =	4 ozs.
„ II.	Crystallised sulphite of soda	10 grms. =	154 grs.
	Distilled water ...	80 c.c. =	3 ozs.

Both solutions will keep, and may be used several times. The negative is laid in Solution I. until it becomes grey or white, if very great intensification is necessary. *The dish containing the intensifier must be rocked the whole time, or the plate will show marks.*

The negative is then well rinsed (one minute is enough), and put in Solution II., where it becomes black. As soon as this blackening has soaked through the whole film, which may be seen from the back, the negative should be taken out, washed for half an hour, and dried.

With negatives treated with chloride of mercury, diluted ammonia may be used for darkening instead of sulphite of soda—1 part ammonia of 0·96 specific gravity to 20 parts water. But in this case the plate must be very thoroughly washed for at least a quarter of an hour after treatment with the chloride of mercury.

The intensification by the use of ammonia is more powerful, but less lasting, than that by sulphite of soda. After treatment with ammonia the plate must be washed for some minutes until the smell of ammonia has disappeared.

2. URANIUM INTENSIFIER.

Sol. I.	Nitrate of uranium ...	1 grm. =	15 grs.
	Distilled water ...	100 c.c. =	4 ozs.
„ II.	Ferri-cyanide of potassium	1 grm. =	15 grs.
	Distilled water ...	100 c.c. =	4 ozs.

For use, they should be mixed in the following proportion:—

50 parts Solution I.
10 or 12 parts Glacial acetic acid.
50 parts Solution II.

The developer lasts a long time mixed when kept in the dark or in a brown bottle, and can be used several times.

The plate to be intensified having been well washed, can be placed in the intensifying solution either wet or dry.* It soon assumes a deep brown or (after longer intensification) red colour which prints very well. *The negative should not be left in the intensifier too long; it is often sufficiently intensified while it still looks flat to the eye.* As soon as the desired density is obtained the negative should be washed for about ten minutes. The water in which the plate is washed will be repelled as though greasy on account of the acetic acid in the intensifier, the washing must be continued till the water is equally absorbed by the plate. *By too long washing the intensification becomes weaker, and finally disappears altogether.*

The uranium intensifier is more convenient than the chloride of mercury mentioned above, because it consists of one solution. Very flat plates which do not attain sufficient vigour by the chloride of mercury intensifier may easily be brought to the required density with uranium. It is therefore preferable in many cases to chloride of mercury. The permanence of uranium intensified plates also exceeds that of the others.

Partial intensification with uranium. If particular parts only of a negative are to be intensified (such as the foreground of landscapes, if the sky has already vigour enough) proceed in the following way:—

* The dish must be rocked the whole time, or marks may occur on the plate.

First intensify the whole negative, wash it well, and remove all water from the surface of the plate with blotting-paper, so that the film is only moist. Brush over the too vigorous places with diluted ammonia (1 part ammonia of specific gravity 0·96 in 20 parts of water) with a soft hair pencil. The intensification fades quite away in these places. In this way very beautiful effects can be obtained. The negative must be well washed after treatment with ammonia.

Varnishing Negatives.

The varnishing of negatives is not absolutely necessary, but is advisable for those which are much used, or which are to be retouched. Dry plate varnish is to be bought; it is a solution of shellac and sandarac in alcohol. The negative, which must be *perfectly dry*, is carefully brushed over with a soft hair pencil, and then warmed over a gas or spirit lamp till the back of the hand can just bear the heat. Then the varnish is poured over in a way described under "Collodion," and the negative is carefully warmed till the varnish is dry. The varnished negative should not be used for some hours, until the varnish is sufficiently hardened. Plates varnished too cold become milky; while if heated too much they tend to become streaky. The waste varnish should be carefully filtered, and may then be used again.

Zapon varnish gives a much harder, more even and tougher surface than ordinary varnish. It has also the advantage that the plates need not be warmed for its application. Zapon varnish can always be bought ready for use, or it can easily be made at home, by dissolving 10 grms. = 154 grs. Pyroxyline in 4000 c.c. = 140 ozs. Amyl acetate, and leaving the

solution to stand for a week. The author prefers this to alcohol varnishes, and uses it almost exclusively. It is less suitable for negatives which are to be retouched with lead pencil, as it makes the retouching somewhat more difficult.

Negatives which are to be enlarged should either not be varnished at all, or only with Zapon varnish, as the particles of dust in the varnish, which it is hard to avoid, will be enlarged also.

Removing varnish. If an already varnished negative is to be intensified or reduced, the film of varnish must first be removed. For this purpose it is placed in a solution (which may be used again) of 1 grm. = 15 grs. caustic potash in 100 c.c. = 3 ozs. of alcohol. The surface becomes milky, and can easily be rubbed off with the fingers. The plate is then washed until the water is uniformly absorbed.

To remove zapon from negatives lay them first in acetate of amyl, then in alcohol.

Retouching.

Finished negatives have often little faults, such as clear points, etc., which are partly to be attributed to faults in the plates, partly to carelessness in working. These faults must be removed as far as possible by retouching the negative, otherwise they show in the prints.

The negative is placed on a sort of easel called a retouching desk, which can be obtained of all photographic dealers. The negative is lighted by means of a mirror fixed to the desk, so that it can be conveniently looked through.

Faulty places in the negative, like smaller or larger white points or holes in the film, can be filled up with black or dark brown colour by means of a very finely pointed hair pencil. Chinese or Indian ink may be

used, mixed with gum arabic or white of egg, to give the colour a better hold.

Negatives which are in part too dark to print well (for instance, many photographs of landscapes, or pictures in which the foreground is over-printed while the background is not dark enough) may be covered on the glass side without warming with *matt varnish*, which is scraped off after it is dry, so that it only covers the parts which print too dark.

Recipe for matt varnish :—

Ether	190	c.c.	=	7 ozs.
Sandarac	18	grms.	=	278 grs.
Mastic varnish ...	4	„	=	62 „
Benzol	50	c.c.	=	1½ oz.

The solution is filtered for use. The varnish may be coloured red with dragon's blood ; it then acts more effectually.

Certain inequalities in a negative, as well as freckles and wrinkles in portraits, may be removed with a lead pencil.* The places upon the varnished negative which need retouching are rubbed thin with retouching medium, or else the varnish would render it difficult or impossible to use the lead pencil.

Retouching medium is prepared by dissolving

10 grms. = 154 grs. of Gum dammar in
50 c.c. = 1½ oz. Turpentine.

The retouching of portraits requires great experience, and cannot easily be learnt by self-tuition. It is best for amateurs to confine themselves in a general way to the removal of small faults, and to leave greater ones to professional retouchers. The films of negatives ready for printing must, after retouching, be carefully protected from damage. This is best done by laying them in clean white paper (filter paper, or

* Those of medium hardness should be used.

some smooth sort, not drawing paper) in the boxes used for packing dry plates for sale.

Colour-sensitive Bromide of Silver Gelatine Plates.*

Ordinary gelatine plates are actually only sensitive to the blue, violet, and ultra-violet rays of light. If you take coloured objects, such as pictures which contain also yellow, green, and red, with this kind of plate, the latter colours do not act as much as they ought, and therefore appear too dark in the print. For instance, chrome yellow and red lead, which to the eye appear much brighter than blue, come out black in the print, while blue appears far too light—almost white. Consequently a very unnatural copy of the original is obtained.

Similar imperfections are found in photographs of landscapes and portraits. Thus in landscapes the green parts, especially in autumn, when the foliage turns yellow, are generally much too dark; while mountains covered by a bluish haze appear far too light. In portraits freckles are much exaggerated by their yellow colour, and must be removed by retouching.

For taking pictures, landscapes containing much green, portraits in fancy dress, etc., colour-sensitive plates, discovered by H. W. Vogel, are much used. These are plates which by means of suitable preparation (colouring with dyes which absorb yellow, green, and red) are made sensitive also for yellow, green, and red light, and by that means reproduce coloured objects in their true scale of tones.

Colour-sensitive plates are especially used for reproducing pictures in the best establishments.

* Edwards's isochromatic plates are of this description.—*Translator.*

The development, fixing, etc., of colour-sensitive plates are effected in the same manner as those of ordinary ones. But these plates must be exposed to the red light as little as possible, as they easily fog; they should therefore be developed in a covered dish. It is, however, not necessary to be over-anxious about this, as most of the colour-sensitive plates on sale (erythrosin plates and erythrosin silver-plates) are only slightly sensitive to red light. Greater caution is necessary with azalin and cyanin plates, which are sensitive to red.

With erythrosin or azalin plates a yellow screen must be placed before or behind the objective during exposure. The object of this screen is to tone down the blue light, which would act too powerfully in proportion to the yellow, green, and red lights.

Such yellow screens are made of a well-cleaned plate of mirror-glass,* free from faults or bubble (ordinary glass will not do, as it produces blurred images), coated, in a way described under collodion processes, with aurantia collodion,† the composition of which is given below; the screen is then allowed to dry.

Aurantia	0·3 grm.	= 5 grs.
Warm alcohol	50 c.c.	= 1½ oz.
Two per cent. raw collodion	150 „	= 5 „

The aurantia is first dissolved, and, after it is cold, added to the collodion.

As the collodion film is easily damaged, the screen thus prepared must often be re-coated with aurantia and collodion. To avoid this inconvenience two glasses may be used, with their collodion-coated sides cemented together.

* Mirror-glasses which are not quite even and homogeneous in their mass give blurred images, especially with objectives of longer focus.

† Aurantia collodion can be purchased, as well as screens prepared with it.

For this purpose warm both screens, and put some Canada balsam or Venetian turpentine on one; lay the second screen upon it, and move the latter crosswise under slight pressure. Air-bubbles, as well as the surplus cement, are driven out by this means.

The screens are cleaned with turpentine after they are cold.

The collodion should be left standing for a few days before use in case it is not clear. When prepared the aurantia screens should be kept in the dark when not in use, as they soon bleach in light.

The time of exposure will be increased fourfold by the insertion of the yellow screen.

Erythrosin silver plates (Perutz brand) need no yellow screen for landscapes, or portraiture, or for many pictures; but if the latter contain much blue, the use of a yellow screen is then very advisable. They may, however, be prepared with a collodion of paler colour. Take 0·2 grams = 3 grs. of aurantia instead of the 0·3 grams of the former instructions. The exposure required is only threefold that necessary without the screen.

Screens of yellow glass are not to be recommended, as it is very difficult to get them suitably coloured, and by using too dark a screen the time of exposure is unnecessarily prolonged.

Production of colour-sensitive plates by means of baths. The colour-sensitive plates of commerce are produced by the addition of colouring matter (erythrosin, azalin, etc.) to the emulsion before it is spread upon the plates. Plates prepared by baths have the advantage over the emulsion-coloured plates which are on sale of greater sensibility to light of all colours, but have also the drawback that they keep for a very short time only. Without troublesome cleanliness, numerous white points easily appear on the plate; they are

produced by particles of dirt becoming detached from the back of the plate, and fixing themselves upon the film.

For the preparation of the baths for colour-sensitive plates, the solutions given below are used. The plates are immersed in the *carefully filtered solution in a clean dish by the faintest possible red light* for a minute or two, and rocked, and are then dried in the dark on a clean plate-rack, or, better still, in a drying-box, which can be obtained commercially.

If the plates take the colour bath unevenly, or if the white points mentioned above appear, a filtered preparatory bath of 100 parts distilled water and 1 part ammonia (specific gravity 0·96) is used.

The colour bath must be kept in the dark, and may be used again with the addition of a few drops of ammonia; but it is best to use fresh baths.

In most cases erythrosin or erythrosin-silver plates are employed. Azalin and eosin-cyanin plates are only used for pictures with much red in them, as these plates fog more quickly than the erythrosin in consequence of the cyanin they contain. The only plates suitable for the bath process are bromide of silver gelatine plates, which do not contain too much iodide of silver, and are absolutely free from fog.

1. ERYTHROSIN BATH.

Erythrosin solution (1 eryth.* to 1000 water)	50 parts
Distilled water	150 „
Ammonia (sp. gr. 0·96)	2 „

This bath renders the plates sensitive for yellow and green. They must be used with a yellow screen.

* By erythrosin, tetra-fluorescein of soda is here meant. Care should be taken as to this, as other colouring matters are sold under the name erythrosin. It is sold pure by the Aktiengesellschaft für Anilinfabrikation of Berlin.

The plates keep for about 14 days. It is best, however, to use them at once.

2. ERYTHROSIN SILVER BATH.

Erythrosin solution (1 in 1000) ...	50	parts
Distilled water	100	„
Nitrate of silver solution (1 in 1000)	50	„
Ammonia (sp. gr. 0·96)	2	„

This bath renders the plates more sensitive to all colours than the erythrosin bath. The plates are likewise sensitive to green and yellow.* A yellow screen is only necessary for photographing pictures with much blue.

The plates will only keep about 8 days, a shorter time than those prepared in the first way. If freshly immersed plates fog, use less silver solution.

3. AZALIN BATH.

Azalin solution (on sale) ...	20	parts
Alcohol...	10	„
Distilled water	100	„
Ammonia (sp. gr. 0·96) ...	1 to 2	„

This bath renders the plates sensitive to yellow, green and red. They must be used with a yellow screen, and keep about 8 days.

4. EOSIN-CYANIN BATH.

Cyanin solution (1 cyanin in 1000 parts pure alcohol 96 %) ...	4	parts
Alcohol (96 %)	20	„
Eosin-solution † (1 to 1000) ...	30	„
Distilled water	150	„
Ammonia (sp. gr. 0·96)	2	„

* Tetra-bromofluorescein of potassium.

† If the ammonia is omitted from the former recipe plates are obtained which keep better, but whose sensibility to colour is considerably less.

This bath makes the plates sensitive to yellow, green, and red lights, but does not work so well as the azalin bath. These must also be used with a yellow screen; they last eight days.

Working with Films.*

Instead of heavy glass plates several kinds of flexible films, prepared with bromide of silver gelatine emulsion, have recently been introduced. These consist of celluloid, collodion, or hardened gelatine. Of the films on sale the following are worth mention:—

Carbutt's, Anthony's, and Schleussner's celluloid plates; Eastman's transparent films, and Perutz's emulsion films.

The rather thick celluloid plates are treated like glass, but are very dear, and therefore comparatively little used.

With Eastman's transparent films and Perutz's emulsion films the operations of developing,† etc., remain the same as with glass plates, only the drying is done in a somewhat different way.

The transparent films should be laid, after washing, for 5 to 10 minutes in a bath of 100 parts alcohol (96%) and 2 parts glycerine. It is advisable to use a second bath also, as the first soon becomes diluted by the water extracted from the film. Then the films are allowed to drip, and all adhering moisture removed with blotting-paper; they are then put in a copying-press to dry between thick white blotting-paper, which should be changed after a time.

Film negatives, when completed, should always be kept under pressure in a book or copying-press.

* For arrangements for the exposure of films, see p. 13.

† Eastman's transparent films must, before development, lie for some minutes in water, till they no longer curl. The developing solution should be used rather freely.

Faults in Negatives on Bromide of Silver Gelatine Plates or Films, and their Remedies.

1. The plate *fogs*, that is, covers itself in development with a grey layer, which deepens the shadows, and gives the whole negative a flat, monotonous appearance. Causes: (*a*) The plate is *over-exposed*. In such a case the image comes up very quickly in development, and soon fades away into fog. Remedy: Addition of bromide of potassium solution, or use of old developer.

(*b*) The plate has been acted upon by extra light. In this case the fog appears *before* the image, and covers also the unexposed parts of the plate. The camera, dark slides, plate boxes, etc., should be tested as to the admission of light.

(*c*) The developer is too strong, or contains too little potassium bromide; in this case add bromide or dilute the developer.

(*d*) The light from the ruby lamp is too bright, or the red screen transmits injurious rays (see p. 50). Remedy: Develop all plates, but especially colour-sensitive ones, in covered dishes, and do not expose them to the light unnecessarily.

(*e*) The plates are too old, or the emulsion with which they were prepared has a tendency to fog. Remedy: Free addition of bromide to the developer.

Finished negatives which are fogged are best treated by first reducing them (see p. 92) until the fog has completely disappeared, and then, after a thorough washing, intensifying to the required density.

2. *A yellow, red, or brown colouring* over the whole plate sometimes occurs through too long development, especially with pyro. and potash, or else through old deep-coloured developer, as well as through too old a fixing-bath. Remedy: The acid fixing-bath

described on p. 91 may be used, or the fixed and well-washed negative may be laid in a mixture of 100 parts saturated solution of alum and 3 parts hydrochloric acid. They must then be well washed.

The following solution also works very well:—

Alum ...	... 30 grms.	=	470 grs.
Citric acid ...	... 30 ,,	=	,, ,,
Green copperas	... 90 ,,	=	1390 ,,
Distilled water	... 600 c.c.	=	21 ozs.

3. *Green fog* often occurs if there is any hypo. in the developer.

4. *Silver fog*, that is, a mirror-like covering of the plate, seen in looking *at* it, which occurs through hypo. in the developer, as well as through too long development (especially with hydrokinone) without further cause. Remedy: Lay the negative in the reducer with ferri-cyanide of potassium mentioned on p. 92, till the silver fog has faded out, then wash immediately.

5. *White fog* (oxalate of calcium) sometimes occurs with the iron developer if the plate is washed in water containing chalk (hard water). Remedy: Immerse the plates in diluted hydrochloric acid (1 to 20).

6. *Thin pictures* are the result of too thinly-coated plates, or too rapid developer, or of over-exposure, or lack of potassium bromide. Remedy: Intensification.

7. *Hardness*, that is, a picture with too much contrast, is caused (*a*) by under-exposure, (*b*) by developer containing too much potassium bromide, (*c*) too glaring illumination.

Gelatine negatives which are too hard are best treated by turning the silver into chloride of silver, and then developing the plate up to normal vigour.

The fixed and well-washed* negative should be

* Half an hour in running water is sufficient.

laid in the following solution till it becomes quite white (that is, till all the black silver is changed into white chloride of silver) :—

Bichromate of potash	1 grm.	= 15 grs.
Alum	... 5 „	= 77 „
Hydrochloric acid	... 3 c.c.	= 60 minims
Water ...	100 to 150 „	= 3 to 5 ozs.

It is then *well* washed, developed in the usual way to the desired density, and fixed.

8. *Sandy precipitate* occurs upon plates developed with oxalate of iron, if too much iron solution is used. Remedy: Use more oxalate of potash.

9. *Yellow marks, showing dark on looking through*, arise from particles of bromide of silver which have not been removed in fixing. Remedy: Thorough fixing, and rock the fixing dish to prevent air-bubbles from adhering to the plate.

10. *White points like pinholes* occur if the plates are not dusted before being placed in the dark slide.

11. Small, round, white marks occur in development if air-bubbles adhere to the plate and keep off the developer. Remedy: Rock the dish smartly, and go over the plate with a soft brush.

12. *Black finger-marks* are caused by incautiously touching the plate in developing with iron. With alkaline developers (hydrokinone, pyrogallol, eikonogen) the finger-marks are white.

13. *Development stripes*, that is to say, uneven curved lines and sharply defined marks. These occur if the developer does not flow evenly over the plate. Remedy: Use more solution, and rock the dish during development.

14. *Frilling and blisters.* The most fatal fault of gelatine plates consists in the raising, pleating, and partial stripping of the film. If this occurs at the edge it is called frilling; if it occurs in the middle

it is called blisters. It seldom occurs in development; oftener in the fixing-bath; oftener still during washing. Causes: (*a*) Faulty preparation of the plate, (*b*) use of too concentrated or too old a fixing-bath; (*c*) washing in too warm water, or overheating of the developing or fixing solutions. Remedy: Lay the plate after development, and careful washing* in a solution of 5 grms. = 77 grs. alum in 100 c.c. = $3\frac{1}{2}$ ozs. of water.† They must again be well washed before fixing; or the plate may be fixed in the alum fixing-bath described on p. 91. It is also advisable to use the developer and fixing solution cold.

15. *Transparent and dark points.* Faults in the plate.

16. *Black edges* often occur when old developer is used, especially with highly-sensitive plates. No remedy.

17. Streaks and streaky marks is a consequence of faulty plates. No remedy.

18. *Unequal density of the negative after intensification or reduction.* Cause: A half-dried negative. The negative which is to be reduced or intensified must be wholly dry or wholly wet.

19. *The negative is coloured yellow with mercury during intensification.* Cause: Hypo. not sufficiently removed. No remedy.

20. *The negative takes the uranium intensifier unevenly.* Cause: Hypo. not sufficiently washed out. The solution acts in its usual way by depositing a brown precipitate. No remedy.

21. *The negative becomes yellow or brown by long keeping.* Cause: Hypo. not completely removed. No remedy.

* In the alum bath a clayey precipitate appears upon insufficiently washed plates.

† Stronger solutions work more energetically, but often produce a peculiar shrivelling of the film, which renders the whole negative useless.

22. *The negative becomes milky in varnishing.* Cause: (*a*) The plates were not dry enough; (*b*) they were not warmed enough. Remedy: Removal of varnish (see p. 97).

23. *Stripes* occur if the plates are too hot when varnished. Remedy: Removal of varnish.

24. *Brown marks appear on the negative in printing if the albumen paper is moist.* Remedy (for varnished negatives only): Removal of varnish.

2. THE WET COLLODION PROCESS.

The wet collodion process is still in use for the purposes of reproduction, especially in photographing line drawings, as collodion negatives surpass those on gelatine in brilliancy and transparency.

On these grounds collodion negatives are used, for example, almost exclusively for preparing zinc clichés by photo-mechanical methods.

The wet process is not suitable for amateurs.

Scrupulous cleanliness must be observed in practising the wet process; success is impossible without it.

Preparation of the Plates.

The new or already used glass plates are for some days pickled, that is, laid in a mixture of equal parts of raw nitric acid and water, in which *they must be completely immersed*, or marks will occur. Old negatives which have been varnished must have the film of varnish removed before pickling, by leaving them for about twelve hours in a saturated solution of carbonate of soda, and then washing them well. The pickled plates are washed in a great deal of water with the help of a brush, and especial care should be taken to well clean the corners.

Polishing.—Place the thoroughly dried plate in the frame K, which can be adjusted to the size of the

plate by means of a screw; pour on it a few drops of strong ammonia, and rub it with a clean cloth, first from right to left, and then up and down. After this rub the plate with a clean dry cloth; then breathe

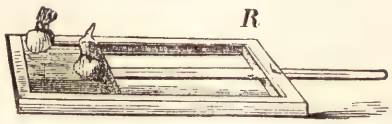

FIG. 54.

upon it; *if it takes the breath equally all over the plate is all right.*

The cloth for polishing plates should not be used for anything else; in place of a cloth a ball made of Joseph's paper (often changed) may be used with advantage.

The polished plate must not be touched on the film side with the fingers. To prevent the collodion film stripping during development and washing, a strip about $\frac{1}{2}$ or $\frac{3}{4}$ c.c. broad round the edge of the plates may be spread (by means of a little piece of flannel put in a cleft of the cork of the bottle containing the solution) with indiarubber solution of the following composition:—

1 grm. = 15 grs. indiarubber is dissolved in 20 parts of chloroform at a high temperature; it is then diluted with 1000 c.c. = 35 ozs. benzol free from water, and filtered.

The prepared plates are then placed upon a stand, with the film side to the right to prevent confusion. The chrome gelatine solution described below may also be used to edge the plates.

Substitute for polishing.—In order to prevent waste of time over polishing, as well as to ensure a firm adhesion of the collodion to the glass, it is well to give the plates a substratum of chrome gelatine. The

following recipe is particularly good: Dissolve 1 grm. = 15 grs. gelatine in 300 c.c. = 10 ozs. warm water, filter it, and when it has cooled add 6 c.c. = $\frac{1}{4}$ oz. of filtered solution of chrome alum (1 to 50). The solution keeps from four to six days, or, with the addition of a few drops of carbolic acid, for a week.

The plates are first pickled, washed *well* under friction, and laid in a dish with distilled, filtered water. The plates are then taken out singly, a portion of gelatine solution poured over, and allowed to run round the plate and then off. The drainings are not collected. The first portion removes the water; after pouring it off a second portion is poured on, and the plate placed upright (film to the right) to drip and dry. If the weather is not too cold it dries within an hour.

In winter the gelatine should be applied in a warm room, as cold plates take it with much difficulty.

Plates prepared in this way remain fit for use for a long time if kept free from dust.

Plates with an under-layer of chrome gelatine should not be used for negatives which are afterwards to be removed from the glass.

Instructions for making up Solutions for the Preparation, Development, etc., of the Plates.

Raw collodion.—20 grms. = 159 grs. collodion wool are dissolved in a mixture of 500 c.c. = 17 ozs. *pure* alcohol of 96° and 500 c.c. = 17 ozs. ether. The solution should be allowed to stand for at least 14 days (best in the dark), and then poured off from the sediment. The solution will keep. Refined raw collodion can be bought ready for use. The alcohol used to dissolve the collodion and the salts should contain no reducing substances. They may be tested as to this by putting a little in a test-tube with two or three drops of solution of silver nitrate, adding a surplus of

ammonia and warming. If the alcohol is good the solution remains clear, otherwise the silver separates out.

The ether also is often impure; this can be tested by putting an alcoholic solution of iodide of ammonia with the ether. The solution ought not to turn brown by separation of the iodine.

Iodising.—In 160 c.c. = 5 ozs. of alcohol of 95 or 96% are dissolved

Iodide of ammonia	4·9 to 5 grms.	=	77 grs.
Iodide of cadmium ...	4·75 „	=	73 „
Bromide of cadmium ...	1·2 „	=	18 „

The solution will keep; it should be kept in the dark, and filtered before use.

Iodised collodion.—Mix

Iodising solution	... ...	150 parts
Raw collodion (2%)	... ...	450 „

This collodion is as suitable for work which includes half-tones (portraiture, landscape, pictures, etc.) as for the reproduction of line drawings.

Before use the collodion must stand for two or three days. It keeps several months in the dark, but by separation of the iodine becomes coloured first yellow and then red. Collodion coloured deep red is useless.

The red collodion does not render the plates sensitive, and works harder than fresh; it can be used for the reproduction of line drawings. It is too hard for work requiring half-tones.

Negative silver bath.—50 grms. = 771 grs. crystallised nitrate of silver are dissolved in 500 c.c. = 17 ozs. distilled water.

After it is perfectly dissolved add 12·5 ccm. (say ½ oz.) iodide of potash solution (15 grs. to 4 ozs. distilled water), and shake it well until the separated iodide of silver is again dissolved. Then add enough

pure strong nitric acid for the bath to give an acid reaction (turn blue litmus paper red). About two to five drops are necessary.

Developer.—In 1800 c.c. = 63 ozs. of water are dissolved—

Sulphate of iron	...	240 grms. =	3703 grs.
Concentrated sulphuric acid	... ...	6·5 cc. =	¼ oz.
Alcohol (95 or 96%)		225 „ =	8 ozs.

The developer must be well corked, and is best kept in daylight. If it turns yellow it is useless.

Pyro. Silver Intensifier.

Sol. I.	Pyro.	...	10 grms. =	154 grs.
	Alcohol (95 to 96%)		100 cc. =	4 ozs.
„ II.	Nitrate of silver	...	2 grms. =	31 grs.
	Citric acid ...	...	3 „ =	47 „
	Distilled water	...	100 cc. =	4 ozs.

Both solutions will keep for a long time.

For use, dilute 4 parts Solution I. up to 100 parts with distilled water, and mix *immediately before use* with an equal quantity of Solution II. (For plates 5″ × 7″ about ¾ oz. of intensifier is required.)

The diluted pyro. solution only keeps for a short time; do not dilute more than you can use in a few hours.

Iron and Silver Intensifier.

In place of pyro the ordinary developer may be used. Mix one part developer with one to two parts Solution II.

Fixing Baths.

Sol. I.	Hyposulphite of soda	100 grms. =	1543 grs.
	Ordinary water ...	500 cc. =	17 ozs.

The addition of 50 c.c. = 1½ oz. acid sulphite of

soda to 1 litre = 35 ozs. of fixing solution is very advisable, but not absolutely necessary. The yellow colouring of the plates resulting from too long development with pyro. is removed by this means :—

Sol. II. Cyanide of potash ... 20 grms. = 308 grs.
Water ... ... 500 cc. = 17 ozs.

The fixing-bath hyposulphite of soda is to be preferred, because the silver of the negative is easily acted upon by the solution of cyanide of potash. The latter has the advantage, however, that foggy negatives are cleared by it.

Preparation of Plates.

Before beginning the preparation of the plates the operator should assure himself that all is ready for the exposure, that is, that the object to be taken is in focus, and all chemicals properly prepared.

Filtration of the silver bath.—The silver bath is filtered, and then skimmed by placing in a clean dish, and holding strips of writing paper, somewhat longer than the dish, in the fingers perpendicular to the edges, and drawing in this position over the surface.

This process is repeated with fresh strips till they appear unsoiled, and then the dish is covered with a clean piece of cardboard to prevent dust from falling in.

A silver bath that has been used before may be treated in the following way before use : Add *about one drop* of a solution of 15 grs. permanganate of potash in 4 ozs. of water to the bath to be restored, and shake it up. If it contains organic impurities the first drop will change colour instantly ; if it contains less the bath first turns rose-red, but soon takes a darker colour.

The addition drop by drop of the solution of permanganate of potash is continued until the bath takes a pale rose colour, which does *not* fade after a minute's

shaking. (The colour *always* disappears after a longer shaking.)

The bath may be tested by its reaction with litmus paper. It must act as *an acid*, that is, turn blue litmus paper red. If necessary, nitric acid may be added drop by drop.

Dusting the plates.—The plates must be dusted before coating with collodion; they should be brushed over, both in front and behind, to the corners and edges, with a very clean camel-hair pencil. This should never be laid upon the table, but hung up on a nail. The following operations up to and including fixing are to be carried on in the dark room by yellow light

Collodionising.—The uniform coating of a plate with collodion is an operation in which experience is necessary to success. Beginners learn best by making trial coatings of bad plates of glass with old, useless collodion.

The collodion bottle is cleaned round the mouth, and then opened *without shaking* (for this would disturb the precipitate which is always present), and gently inclined, then a few drops are allowed to flow out (to wash away any impurities in the neck), and the whole quantity poured on to the plate.

The glass plate * (see Fig. 55) should first be held quite horizontal by the top left-hand corner (*a*), then with the right hand a rather large quantity of collodion is poured in the middle so as to spread out on all sides in rings. If enough has been poured on, incline the horizontal plate *very gently*, so that the collodion flows first to the corner *b*, then to the first corner *a*, then to *d*, and lastly to *c*. Then hold the neck of the open collodion bottle under *c*, and *tilt the plate slowly so that it turns in its own plane to cause the "overflow"* of the surplus collodion into a suitable bottle. Mean-

* Large plates which are difficult to hold may be supported by the cork of a bottle placed underneath.

while bring the plate *gradually into a vertical position with a continual twist.* The collodion evaporates fast, especially when being poured off, and if not turned will dry in diagonal stripes. The twist is performed in the plane of the plate.

It is important for beginners to remember that the plate must be kept continually on the turn even while the collodion bottle is being stoppered.

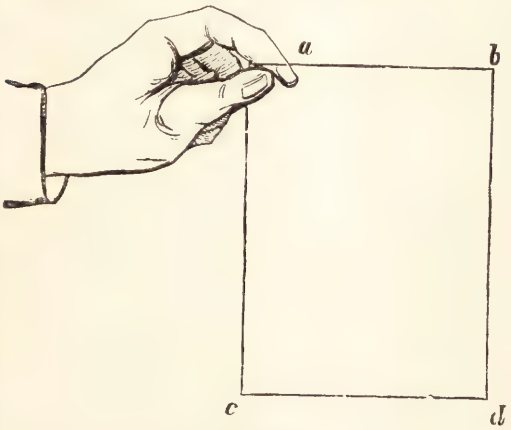

FIG. 55.

Observe when the collodion thickens and ceases dripping. If the lower edge at the corner from which the collodion was poured off has already become so firmly fixed that rubbing with the finger tears it to pieces, the moment has arrived at which the plate must immediately be put into the silver bath. If it is not immersed till too late the upper part, which is too dry, is either not sensitised at all, or only superficially, and there is formed a dry edge, which becomes transparent (see p. 127).

Further, it is important that the collodion should not flow over the back of the plate, or it makes the front dry unevenly by cooling it, and also contaminates the silver bath by the formation of little bits of skin. It is also important that the fluid containing ether should not touch the fingers, as grease may be dissolved, which would cause dark streaks.

The collodion poured off from the plate is generally contaminated with dust, and is therefore placed in a separate bottle to prevent it from spoiling the stock of collodion. The collodion drainings may be used again after being allowed to settle for 8 days, and the clear part decanted off.

Sensitising. Take the plate with the right hand by the corner *d*, place it with the edge *a* (the long side *ac* being downwards) in a dish held in the left hand, and somewhat tilted so that the collodion film is uppermost, turn it first to the right hand and then to he left, so that *the silver bath flows over the whole plate in one movement*. The plate is soon coloured yellow by the formation of iodide of silver. After some time the plate is raised with a little hook of silver or horn, and moved continually up and down until, seen by reflected yellow light, it appears equally moist all over, and the solution is not repelled by any greasy place. If this is the case, take out the plate with a *quick* movement in order to wash away any impurities which would otherwise remain upon the film side.

Placing the plates in the dark slide. The plates when taken out of the bath are put the same way up (consequently with the side *ac* downwards) upon clean blotting-paper leaning against a stick to drain. Meanwhile some little pieces of clean blotting-paper are placed in the corners *d d d d* of the dark slide (see Fig. 8, p. 9), and lay the plate with the side *ac* under (*ab*, for upright pictures) in the almost horizontally placed dark slide, so that it rests equally upon the

four silver or glass corners, and so that the collodion film faces the flap *h*. Then the dark slide is closed. The *last is always placed in a nearly horizontal position*, because otherwise the lower edge of the plate is covered by the liquid rolling back and the plate is soiled.

The Exposure.

Wet collodion plates require about ten times the exposure necessary for gelatine dry plates (see p. 72).

The wet plates dry easily, especially in hot weather, and keep only a short time. The arrangements of the studio must then be all made *before* the preparation of the plates, so that the several processes can follow each other quickly and punctually. For very long exposures the plates are treated with the filtered solution given below to prevent their drying, and moved about as in collodionising, until the greasy stripes have faded away.

Distilled water	... 35	c.c	= 1 oz.
Alcohol (95 or 96%)	... 3	,,	= 50 minims.
Citric acid ...	... 1	grm.	= 15 grs.
Glycerine ...	... 6	c.c.	= 100 minims
Nitrate of silver	... $2\frac{1}{4}$	grms.	= 34 grs.

Plates prepared in this way may be exposed for an hour without drying.

Moist grey blotting-paper also laid in the camera or at the back of the plate will prevent it from drying too quickly.

Development.

The dark slide containing the exposed plate is immediately put in its original horizontal position in the dark room. Developer, intensifier, fixing solution, etc., must all be ready.

The sensitive plates are taken carefully out, for

which purpose the back D of the dark slide is unfastened (see Fig. 8), and the slide taken up in the left hand so that the thumb holds the lid D fast, and prevents it falling out, then the dark slide is turned over so that the plate falls upon the hand held flat underneath it. The dark slide is then laid away (to be carefully wiped out afterwards), and the plate held with three fingers of the left hand by the corner *a* (Fig. 55) if the side *ac* was underneath in the dark slide, or by the corner *d* if it was the side *ab*, so that the side *ac* (or *bd*) lies horizontally towards the breast. If *ac* was underneath in the dark slide the plate is tilted so that *ac* lies somewhat lower than *bd*; if *ab* was underneath the plate must be so sloped that *ab* is lower than *cd*.

This should be done so that the used stream at the lower edge should not flow back over the plate, because it easily causes streaks. *The developer is now poured evenly in one motion* along *bd* (see p. 117) or *ca*, so that it covers the plate all at once. About 30 c.c. (1 oz.) of developer are necessary for a plate 13 × 18 cm. (5″ × 7″). Part of it flows down the sloping side and washes off the other used solution. If the developer does not flow over the plate evenly without stopping, streaks are sure to result. *It is important for the developer to contain the right amount of alcohol.* If the collodion film repels the developer too much, the alcohol in it is to be increased in *old* baths, or to be lessened in fresh.

The too hasty application of the developer to the collodion film should be avoided, as it generally produces a permanent shining appearance, while by pouring on too quickly the silver solution which furnishes the image-producing silver is too quickly washed away.

After pouring on the developer the image appears.*

* The chemical reaction in development is as follows: The developer reduces the silver solution on the plate to metallic

If this takes place too quickly the plate is over-exposed; if the opposite under-exposed. In a normal development the brightest parts of the original appear first, then the less transparent, and lastly the dark parts. The appearance of the image should be carefully watched while the developer is allowed to flow in all directions, and care should be taken that all details in the dark parts come up properly. Should they not do so, in spite of a long development, the plate is under-exposed. This fault cannot be remedied by any of the following operations.

An over-exposed plate usually has plenty of detail in the dark parts, but fails to convey the brilliant contrasts between light and shade that make up the beauty of a picture. The plate is monotonous, and prints from it share this quality.

When the image is fully developed (the duration of development is a matter of experience) the solution is poured off, and the back of the plate washed with the hand. The image is then tested by looking through it. If it is faulty, throw the plate away; if otherwise proceed to intensification.

Intensification.

The developed image is hardly ever dense enough, and must therefore be intensified.

1. *Pyrogallol-silver intensification.* The plate is to be washed *carefully* for about ½ up to 1 minute. The intensifier is then mixed (see p. 114) in a *clean* glass, and poured over the plate, which must be continually rocked to ensure that no part remains uncovered. After some time the intensifier is poured back into the glass, and the density of the plate tested by transmitted light. If it has enough density for printing

silver, which separates out as a black powder, and only precipitates itself on the exposed parts of the plate. The iodide of silver in the plate remains unchanged during development.

(and the determination of this is purely a matter of experience) the intensifier is removed. Otherwise, pour it on again; if it still appears clear, brown colour does no harm. If it is thick pour it away, and use fresh. In reproducing line drawings, which must be intensified until the paper background of the negative appears quite opaque, this must be repeated many times.

2. *Iron and silver intensifier.* The iron and silver intensifier works quicker than pyro., but is only to be recommended to practised workers. Mix iron developer with an equal or double volume of silver solution (see p. 114), and proceed as above. *There is no need, however, to wash the plate before intensification.*

Fixing and Washing.

The well washed plates are now covered with the fixing solution (see p. 114) if cyanide of potash is used, or immersed in it if fixed with hypo., until all the iodide of silver is dissolved. This time is known by the disappearance of all yellow places on the plate (seen from the back). The yellow iodide of silver left after fixing does not colour it.

The plate is then very carefully washed for about three or five minutes, and placed on a plate-rack to dry.

Intensification after Fixing.

Half-tone photographs are almost always intensified in the way given above before fixing, but in *reproducing line drawings* a different intensifier, which can be used after fixing, is often employed. *The most careful washing is necessary with all these intensifiers, or marks are caused by traces of hypo. The plates should not be dried after washing*, as otherwise they do not take the intensifying solution (moistening afterwards is of no use). If the intensification cannot be performed immediately after washing, lay the plate in a dish of water meanwhile.

With silver the intensification may be continued as long as desired. This is not the case with the following intensifiers. In these the highest attainable degree of intensification is proportional to the amount of silver contained in the negative. The intensification ceases when all the silver has entered into other combinations; for instance, ferro-cyanide of silver in intensifying with lead. The plates should therefore not be too thin, and should, if possible, be raised to the required density by a short silver intensification in the way given above.

1. IODIDE OF MERCURY INTENSIFIER.

Sol. I.	Chloride of mercury	1 grm.	= 15 grs.
	Distilled water ...	100 c.c.	= 4 ozs.
„ II.	Iodide of potash ...	3 grms.	= 47 grs.
	Distilled water ...	100 c.c.	= 4 ozs.

Mix I. and II. The mixture will keep, and may be used repeatedly

The solution should be poured over the well-washed plates, or they should be laid in it. They then assume a uniform dark brown colour. After washing, diluted ammonia * (1 part ammonia of sp. gr. 0·96 in 20 parts of water) is poured over them, and they are removed and dried.

If the solutions are used consecutively the negatives will be richer in contrast.

2. LEAD INTENSIFIER.

Sol. I.	Nitrate of lead ...	4 grms.	= 62 grs.
	Ferri-cyanide of potassium	6 „	= 93 „
	Distilled water ...	100 c.c.	= 4 ozs.
„ II.	Bichromate of potash	10 grms.	= 154 grs.
	Ammonia (sp. gr. 0·91)	10 c.c.	= ¼ oz.
	Distilled water ...	100 „	= 4 ozs.

* The use of ammonia is not absolutely necessary.

Both solutions will keep, and may be used repeatedly. Solution I. is sensitive to light, and should therefore never be unnecessarily exposed to daylight.

The *well-washed* negative is laid for 10 or 15 minutes in Solution I. (It is best used in a covered dish on account of its sensitiveness.)

The plate takes a yellowish white colour by the formation of ferro-cyanide of silver and ferro-cyanide of lead. After washing well, the plates are treated with Solution II., and become a bright orange colour by the formation of chromate of lead. They are then washed and dried.

With many kinds of collodion it often happens that the films of negatives intensified strongly with lead or mercury leave the glass or crack. To hinder this treat the moist negatives with a filtered solution of 154 grs. gum arabic in 5 ozs. of water before allowing them to dry.

3. BROMIDE OF COPPER INTENSIFIER.

Sol. I.	Sulphate of copper	100 grms.	=	1543 grs.
	Distilled water	1200 c.c.	=	42 ozs.
	Bromide of potassium	40 grms.	=	617 grs.
„ II.	Nitrate of silver ...	5 grms.	=	77 „
	Distilled water ...	100 c.c.	=	4 ozs.
„ III.	Cyanide of potash	1 grm.	=	15 grs.
	Distilled water ...	200 c.c.	=	7 ozs.

The solutions can be used repeatedly. Solutions I. and II. will keep.

Filtered Solution I. is poured over the *carefully washed* plates, or they are immersed in it. They immediately become white, *whereupon they are thoroughly washed.* They are then treated with Solution II., which turns them a deep black colour.

They are again washed well. If the negative has

not sufficient density, the intensification may be repeated.

Negatives which have been intensified up to too great density may be reduced by treatment with Solution III.

Intensification with bromide of copper gives negatives of great covering power, which have the advantage over those intensified with lead that the film shows no tendency to crack or leave the glass. It has the advantage of keeping better than the iodide of silver intensifier.

4. INTENSIFICATION WITH GOLD.

This intensification is often used in autotype establishments, and has the advantage of a greater simplicity and speed of performance, but stands below the bromide of copper process in covering power.

Dissolve 15 grs. chloride of gold in 35 ozs. distilled water, and filter.

The well-washed negative is simply immersed in this solution until the required strength is attained.

VARNISHING.

To protect the collodion film of the negative (which is especially liable to damage) it must be varnished. For this purpose the ordinary "Varnish for Collodion Plates" is used.

First remove the loosely hanging or cracked pieces of the collodion film round the edge of the plate, warm the plate slightly over a lamp, pour the varnish on like collodion, and allow the excess to run off exactly as described on p. 116. Then place the plate on clean blotting-paper. Overflowing upon the back of the plate should be avoided, as it causes unequal drying of the corresponding parts on the front.

Zapon varnish cannot be used for collodion negatives, as it dissolves collodion.

Colour-sensitive Wet Plates.

Ordinary wet plates are, like ordinary bromide of silver gelatine plates, only sensitive to blue and violet light.* The following recipes for colour-sensitive wet plates are to be recommended. The photographic operations remain as before, but a longer time of exposure is necessary. On account of the sensitiveness of the plates to yellow and green light it is advisable to work in red light.

Colour-sensitive collodion. Dissolve ½ grm. (say 8 grs.) of eosin (soda salt of tetra-bromofluorescein) or erythrosin (sodium salt of tetra-iodo-fluorescein) in 180 c.c. = 6 ozs. 95% alcohol, and filter. Further, dissolve 2 grms. = 31 grs. bromide of cadmium in 30 c.c. = 1 oz. alcohol, filter, and mix one volume of the filtered solution with three volumes of neutral celloidin collodion with 2% pyroxylin. For many purposes a thicker film is desirable. Such a one may be obtained by dissolving 2½ grms. = 39 grs. bromide of cadmium in 30 c.c. = 1 oz. of alcohol, filtering and mixing (in the above proportion) with 2½% (instead of 2%) collodion. Such collodion is less fluid, and takes longer to silver. To 95 parts of the above-mentioned collodion take 5 parts eosin solution, and shake up well. The collodion is best kept in the dark.

Silver Bath.

Nitrate of silver	... 50 grms.	= 771 grs.
Distilled water	... 500 c.c.	= 17 ozs.
Iodide of potassium solution (1 to 100)	... ... 13 c.c.	= ½ oz. (nearly)
Glacial acetic acid until a markedly acid reaction is given (at most 6 drops is enough)		
Alcohol	... ... 15 c.c.	= ½ oz.

* For more about colour-sensitive plates see p. 99.

Sulphuric acid is not to be recommended for the acidulation, as it destroys the colouring matter. A surplus of acid also is to be avoided.

The sensitiveness of the colour-sensitive plates is about $\frac{1}{3}$ that of the ordinary wet plates (without using a yellow screen). The time of exposure is quadrupled (see p. 101) by the interposition of a yellow screen.

Before development the plate should be immersed for 5 minutes in a second silver bath of

Nitrate of silver	... 50 grms. =	771 grs.
Sulphate of ammonia	100 „ =	1543 „
Distilled water	... 500 cc. =	17 ozs.
Sulphuric acid (sp. gr. 1·22)		4 to 8 drops.

This bath must always have an acid re-action, and should be filtered, skimmed, etc., before use like an ordinary silver bath for negatives.

The Chief Faults in Wet Collodion Processes, and Their Remedies.

Faults in Brushing and Cleaning. 1. *Lines in the shape of moss*, proceeding especially from the lower corners. Cause: Dirty dark slides. Remedy: Wash out the dark slide with warm water, dry, and asphalt it. To coat it with negative varnish also helps for a short time.

2. *Soiled edges or marks* going from the corners, and stretching out more or less in the middle, arise from imperfect cleaning of the rough corners of the plate, or by the touch of dirty fingers.

3. *Brush stripes* often show themselves; they are caused by a dirty or hard brush.

4. *Bright, irregular points and short streaks* arise from dust and wood fibres which fall upon the plate in opening the dark slide. Remedy: Dusting out the dark slide.

Faults in Collodionising. 1. *The plate comes out of*

the bath with a transparent edge; this comes from immersing it too late after coating with collodion.

2. *The film is soft*, and easily gives way in the bath. Cause: Too long immersion, too old collodion, or a very acid bath.

3. *The film is unequally thick* in consequence of unequal coating.

4. *Marks* caused by the tips of the fingers show that they are dirty. The collodion must not touch the fingers.

5. *Thick and thin places, striped in parts*—a consequence of air-bubbles, which first appear at the end of the collodionising, or of unequal drying caused by the warmth of the finger, or the evaporation of collodion spilt on the back of the plate.

6. *Diagonal stripes.* Cause: The plate was not properly turned about after coating.

7. *Comet-like black marks.* Cause: Freshly iodised collodion used before settling.

8. *Want of sensitiveness* is caused by old collodion which has become a deep red.

9. *The film adheres to the plate with difficulty.* Cause: Old acid bath, badly polished plate, or old collodion. Remedy: Use of a substratum of chrome gelatine (see p. 111).

Faults in the Silver Bath. 1. *Fog* occurs through an alkaline silver-bath or organic impurities. Remedy: Acidulate the bath with nitric acid, or use permanganate of potash (see p. 115).

2. *White transparent stripes* (sensitising stripes) occur if the silver bath used for dipping does not flow over the plate equally without interruption.

3. *Black Stripes* proceeding from the hooks. Cause: Unclean gutta-percha or silver hooks.

4. *Remarkably transparent, not sensitive plates*, are sometimes produced by great heat. Remedy: Cooling the silver bath with ice.

5. *The plates appear covered with meal-like marks.* Cause: Precipitation of iodide of silver. Remedy: Filtration of the bath and cooling, or the admixture of an equal quantity of 10% solution of nitrate of silver or treatment like 6.

6. *Numerous small holes like pinholes* occur if the bath is too strong in iodide of silver. Remedy: Cooling the bath or diluting it to one-fourth (by which means the excess of iodide of silver is removed), filtering and evaporating it down to the original volume.

7. *Non-sensitiveness* is caused by too great acidity or by organic substances. Remedy: Neutralisation of the surplus acid by the addition, drop by drop, of a solution of carbonate of soda, or treatment with permanganate of potash (see p. 115).

8. *Grey, gritty spots* are caused by insufficient skimming.

Faults of Exposure. 1. Fog is caused by side-light, or sometimes by a very bright sky, or the sun shining into the objective.

2. *Marbled spots and dry places* are caused by long exposure, especially in the heat. For remedies see p. 119.

3. *A hard picture*—too short an exposure. Flat pictures occur through over-exposure.

4. *Unequal intensity of the picture.* Cause: Unequal illumination, especially with drawings.

5. *Foggy marks* occur through reflection, which causes cross illumination, especially with oil paintings.

Faults of Development. 1. Fog is sometimes caused by the developer not containing enough acid.

2. *Bright appearance* on the side poured upon. Cause: Pouring out the developer too hastily. (See p. 120).

3. *Fine black curved lines* (developing stripes). Cause: Unequal flow of developer.

4. *The film rejects the developer.* In this case the

developer contains too much alcohol (as in fresh silver baths), or too little (as in old ones).

Faults in Intensification. 1. *The intensifying solution may be repelled,* and causes spots (especially in intensifying with iron); this is caused by want of alcohol.

2. *Pale spots* show themselves if the developer (of any kind) does not flow equally all over the plate.

3. *A grey granular precipitate* if the iron intensifier is allowed to remain in use until it is thick.

4. *A bluish precipitate* in the shadows is caused by want of acid, or by use of old pyro.

5. *Thick places* appear if the intensifier is always poured upon one and the same spot, especially in a long intensification.

6. The plates sometimes assume a *brownish* or *yellowish colour* by too long intensification with pyro. Remedy: Fixing in a bath mixed with acid sulphite lye (50 c.c. = 1½ ozs. sulphite lye in 1 litre = 35 ozs. fixing solution), or in dealing with already fixed plates. Treat them with diluted sulphite lye, or a solution of 2 gr. = 31 grs. sulphite of soda in 50 c.c. = 1½ ozs. of water, to which hydrochloric acid or sulphuric acid is added until the smell of sulphurous acid appears.

7. *The plate assumes a black colour while being intensified with pyro.* Cause: Iron developer not properly washed out, and combines with pyro. to give the colour.

Faults in Fixing. 1. *The plate is greenish or bluish.* This arises from fixing plates containing iron salts with cyanide of potash, and can be avoided by a previous thorough washing.

2. *Thin places* are caused by the use of a strong solution of cyanide of potash, which corrodes the plate.

Faults which appear in drying. The film may leave the plate in drying; this occurs in thinly coated plates and those that have been long intensified, especially

by the lead process. Remedy (not always possible): Gumming the plates (see p. 124).

Faults in Varnishing. 1. *Solution of the film* so that the picture disappears. Cause: Too much alcohol in varnish. 1% of water should be added, and the varnish warmed for some time.

2. *Dull film* caused by too cold a plate or thin varnish.

3. *Stripy film.* This occurs with too hot a plate, or if it is unequally moved about after pouring off the varnish.

3. COLLODION EMULSION PROCESS.

The bromide of silver collodion emulsion process has the advantages over the wet collodion process of greater simplicity and cleanliness. Further, the emulsion may easily be made sensitive to colour, and is therefore pre-eminently fitted for taking coloured objects.* The negatives are remarkable for great clearness and fineness of grain.

Of the collodion emulsions now on sale, that prepared by Dr. Albert of Munich is most to be recommended. It is sold together with a colour solution, ready for use, and keeps for an unlimited time.

PREPARATION OF THE COLLODION PLATE.

The glass plates are accidulated and carefully polished as described on p. 110, or, better still, coated with an under-film of chrome gelatine given on p. 112. *Before use, the emulsion must be well shaken until no precipitate of bromide of silver remains at the bottom of the bottle.*

For preparing colour-sensitive plates 10 c.c. = $\frac{1}{2}$ oz.

* The process of collodion emulsion sensitive to colour is easier and simpler to practise than the wet process described on p. 125, and is therefore much used of late in establishments for reproduction.

nearly of colouring solution should be added to 100 c.c. = 4 ozs. of the emulsion, and well shaken up. It should then be allowed to stand for about five minutes, and then poured over the plate in the way described on p. 116. As soon as the film is stiff, and no more emulsion drops off it, it is laid in the dark slide with the wetted side downwards.

The coating with colour-sensitive emulsion must be performed in red light. Uncoloured emulsion may be used with yellow light. Not more emulsion should be coloured than is to be used during the day, as it soon spoils.

The Exposure.

The collodion plates are to be exposed in a moist condition, as they are not sensitive when dry. The *sensitiveness* of the uncoloured emulsion is about $\frac{1}{3}$ that of a wet collodion plate, and consequently about 30 times less than a bromide of silver gelatine plate. The coloured emulsion, on the other hand, nearly attains the sensitiveness of ordinarily sensitive dry plates.

The use of a yellow screen is but seldom necessary; in this case a screen coated with 0·2% aurantia collodion is used (see p. 101).

Development and Fixing.

Concentrated hydrokinone developer for collodion emulsion plates:—

Sol. I.	Distilled water ...	500 c.c.	=	17 ozs.
	Crystallised sulphite of soda	200 grms.	=	3086 grs.
	Carbonate of potash	200 „	=	„ „
„ II.	Hydrokinone ...	25 „	=	385 „
	Alcohol (96%) ...	100 c.c.	=	4 ozs.
„ III.	Ammonium bromide	25 grs.	=	385 grs.
	Water	100 c.c.	=	4 ozs.

For normal negatives, 100 cc. = 4 ozs. Solution I. are mixed with 5 c.c. = 84 mins. Solution II. and 7 c.c. = 117 mins. Solution III. If denser negatives are desired, Solution II. may be increased (up to 10 c.c. = 168 mins.). The increase of Solution III produces greater clearness.

For use, 15 c.c. = $\frac{1}{2}$ oz. of concentrated developer should be diluted with 100 c.c. = 4 ozs. of water.

Before development the plate should be laid in water till it no longer rejects it as if greasy. It is then allowed to drip, and developed in a dish. The image soon appears (much sooner than on gelatine plates), and the development comes to an end in a short time. The plate is then taken out, and fixed in the acid fixing bath described on p. 91. The fixing also is very soon done. It is then washed for from three to five minutes and dried.

Intensification and Reduction of Collodion Plates.

Intensification is seldom necessary. It can be done after developing and washing with the pyro. and silver intensifier described on p. 114 (see also p. 121).

For reduction, the reducer described on p. 93 with ferri-cyanide of potassium is used.

Varnishing.

The varnishing is done in the way described on p. 125, with the proper varnish for collodion plates.

Faults in the Collodion Emulsion Process.

1. *The plate fogs.* Cause: (*a*) The emulsion was too warm during colouring. Remedy: In summer the emulsion should be stood in ice for some time; (*b*) the coloured emulsion has been kept too long

before use; (*c*) faulty or too bright illumination of the dark room (see p. 50); (*d*) camera or dark slide admit light; (*e*) the developer contains too little potassium bromide.

2. *White points* with a fine dark point in the centre. Cause: Dust. Remedy: Dust out the dark slide and the camera. The preparation with chrome gelatine as well as the coating with emulsion must take place in a room free from dust.

3. *The film leaves the glass.* Remedy: Edge the plate with chrome gelatine if it is to be printed from at once, or use plates already provided with an undercoating of chrome gelatine.

4. *Developing streaks* occur if the plates have not been allowed to drip enough before development.

5. *Plates are too thin and weak* if the emulsion has not been shaken enough before use (see p. 131), or by incorrect exposure.

4. Preparation of Duplicate, Reversed, Enlarged, or Reduced Negatives.

Preparation of duplicate negatives.

In the dark room the negative is laid in a printing frame (see Fig. 56), with the film upwards, an ordinary bromide of silver gelatine plate upon it, so that the two films touch, and close the frame. Then place it about a yard from a gas burner or paraffin lamp, and expose it for a few seconds.* Then develop, fix, and wash in the way given on p. 89, and a positive picture on glass is obtained, which is called a Diapositive or Transparency. After this positive is thoroughly dry, a copy of it may be made upon a gelatine plate

* By using a bat's-wing burner three or four seconds' exposure is necessary for an ordinary negative at the distance of a yard, four times as much at double the distance, one-fourth of the time at half the distance.

in the way described above, and a negative is obtained once more.

In this way strong negatives may be obtained from flat ones, and *vice versâ*. If vigorous negatives are desired give a short exposure, and use a developer containing a good deal of potassium bromide; if a soft negative is wanted expose for a long time, and use but little bromide in the developer.

Reversed Negatives.

For certain photographic processes, for instance, pigment and collotype, reversed negatives, that is, those whose sides are exchanged, are used. Such negatives may be prepared in the following ways :—

1. *By removing the film with the image.* Collodion negatives may easily be removed from the glass in the following manner :—

The half dry negative is placed on a stand in a perfectly horizontal position to prevent air-bubbles, and the following gelatine solution poured over it * :—

Gelatine	... 100 grs. =	1543 grs.
Distilled water ...	... 400 c.c. =	14 ozs.
Glycerine	... 10 „ =	¼ oz.
Alcohol (95%) ...	... 100 „ =	4 ozs.

The gelatine is first left in water for some time to soak, and is then melted by putting the vessel into a warm water bath of 167°—190° F. The alcohol ought to be added quite gradually while being stirred and after the perfect solution of the gelatine. Then filter through flannel.

The gelatine solution should be poured *warm* upon the negative, and spread out evenly with a glass rod. The plate is then laid in a place free from dust to

* 25 c.c. necessary for a plate 13 × 18 cm.

dry thoroughly. When this is done flood it with 1½% raw collodion,* let the latter dry, and then cut the film all round, so that it easily separates from the glass.

The stripped negative is placed under pressure, otherwise it easily becomes curved, and then will not lie flat in printing, and so makes blurred prints.

Gelatine films can only be removed easily by the use of so-called stripping-plates, which are specially prepared for this purpose.

In this case the *dry* negative is covered with 1½% raw collodion; pour off the first gelatine solution as soon as it is dry, and proceed as directed above.

2. *By solarisation.* The negative is put in contact with a dry plate in a printing frame, as mentioned aboved. A piece of black paper is placed behind, and it is exposed to daylight. One or two minutes of daylight is enough exposure for a normal negative. The image must be faintly visible as a positive. It is thereupon developed, but with hydrokinone (and indeed with used developer, see p. 79), and so a negative, not a positive, as was to be expected, is obtained.

By the long exposure the exposed parts "solarise," that is, they lose the faculty of darkening in the developer, so that no positive can be obtained by development. The cause of this solarising effect is not yet fully understood.

Here one is able to produce either hard or soft negatives; a short exposure gives soft, a long exposure hard ones. If it is exposed too long the image appears very slowly and is fogged; if it comes up very quickly it had too short an exposure.

The negatives have generally a light fog, which is, however, removable by reduction.

* It is not absolutely necessary to use collodion, but it has the advantage of checking any tendency of the negative to curl.

3. *According to Eder and Pizzighelli.* A bromide of silver gelatine plate* is immersed for 2 minutes in a filtered bath of 4% potassium or sodium bichromate, and dried in the dark. A copy is made under the negative in diffused daylight up to the degree 17 to 18 of Vogel's photometer described under "Pigment Printing." †

The printed plate, upon which a positive is faintly visible, is to be washed in water very carefully for at least an hour, developed by faint daylight with oxalate developer, and fixed. The fully exposed part of the plate rejects the developer, so that it can only act on the parts which have been exposed for a shorter time, or not at all. Consequently, a negative is again obtained.

4. *By means of the powder process.* This process depends upon the fact that films of gum arabic, rendered sticky with sugar or honey, or honey in the presence of chromium salts, lose this property in light. Consequently, if a plate covered with such a film is exposed under a negative, and dusted over with soot or powdered graphite, only the unexposed parts will take the powder, and a negative is again obtained.

Sol. I.	Gum arabic ...	80 grms.	= 1234 grs.
	Sugar	200 ,,	= 3086 ,,
	Honey	40 c.c.	= $1\frac{1}{4}$ ozs.
	Distilled water ...	200 ,,	= 7 ,,
	Alcohol (96%) ...	30 ,,	= 1 oz.

The solution is hastened by placing the bottle in warm water. The alcohol should be added after all the rest are dissolved. To this solution 20 or 30 drops of glycerine should be added in wet weather, 30 to 40 when it is dry.

* For this purpose, plates which have been exposed to light, or have become useless for ordinary photographs, may be used.

† Long exposures give hard negatives; short exposures soft ones.

Sol. II. Ammonium bichromate 20 grms. = 31 grs.
Distilled water ... 200 c.c. = 7 ozs.

Both solutions may be kept for an unlimited time.* For use, mix 20 c.c. ($\frac{3}{4}$ oz.) of Solution I., 40 c.c. ($1\frac{1}{4}$ oz.) of Solution II., and 60 ccm. (2 ozs.) of distilled water; warm to 50° C. (122° F.), and filter twice.

By yellow light or lamplight coat with this mixture a sheet of glass (plate glass is the best) which has been rubbed with dilute waterglass,† and then, after

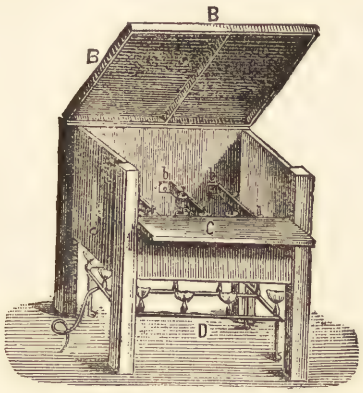

Fig. 56.

drying, well dusted. Let the surplus solution run off; it can be used again after filtration. Then dry the plate on a stand as nearly as possible in a horizontal position, and warm it to 50° or 60° C. (122-140° F.) by a gas or spirit lamp. Larger plates are best dried in a drying cupboard, as the drying then proceeds more evenly and surely. Fig. 56 shows the arrangement of

* The mixed solution lasts for some days; it is useless when it has turned brown.

† Waterglass is silicate of soda.—*Translator.*

such a cupboard.* This consists of a wooden box, with an iron plate for the bottom, under which several gas or spirit lamps are fixed (D). The lid (B) is covered with black stuff, through which moisture can evaporate. The front of the box (C) may be folded down, so as to make the interior more easily accessible; it is held fast by the lid when shut. In the box certain iron bars (*bb*) are fixed by means of screws. A thermometer (*d*) can be introduced through a hole in the side of the box, so that it is always easy to read off the temperature without opening it.

The plates to be dried are placed in the box, in a perfectly horizontal position, by means of the above-mentioned screws and the help of a lever. They are then taken out according to the above directions, treated with the light sensitive solution, and then returned as nearly as possible to the same position. The lid is then cautiously shut up to prevent any particles of dust from falling in. The drying takes about ten minutes. Dust is above all to be avoided.

Now expose the plate under a negative for four to fifteen minutes, according to the density of the negative and the light (with a normal negative up to degree 16 of the photometer described under "Pigment Printing"). The exposed plate upon which the image must be faintly visible is then laid on a white sheet of paper in a half-dark room or by lamplight, and dusted over with powdered graphite† with a soft brush. With a longer exposure in damp weather it is advisable to put the plate again in the drying cupboard for a short time, or to warm it over a gas burner to avoid much moisture. Plates that are too wet easily smear in dusting over. The graphite is spread over the plate as lightly as possible, without

* According to Husnik's Das Gesammtgebiet des Lichtdrucks.

† Finest cleaned sifted graphite, which can be had of Johann Jaber of Nürnberg, is used.

pressure, until the negative appears of the required strength. Then the surplus powder is brushed off, the plate flooded in the way described on p. 116 with 2% raw collodion; after it has stiffened, cut off the edges, and lay it in a dish of water. After a short time the film comes off, and is placed upon a clean glass plate, avoiding air-bubbles.* It is varnished after a thorough drying.

If the plate when being powdered does not take the graphite, either it was exposed too long or the solution contained too little glycerine. If the powder remains adherent to the whole plate, either it was not exposed long enough, or the solution contained too much glycerine. A long exposure gives hard negatives; a short one makes them soft.

The following recipe is used to prepare powder negatives, which do not have to be removed and applied to another glass plate:—

Distilled water	300 c.c.	= 11	ozs.
Gelatine	2 grms.	= 31	grs.
Gum arabic	4 „	= 62	„
Grape sugar	16 „	= 246	„
Ammonium bichromate	8 „	= 123	„
Alcohol (96%)	2 c.c.	= 33	mins.
Glycerine	20 to 30 drops.		

The substances are dissolved in the given order. Gelatine only dissolves in warmth; therefore the solution is placed in a water bath of about 140° F. After complete solution it is filtered, and the plate covered with it and dried, as given above. The exposure and dusting are always done in the same way.

As soon as the negative attains the required strength it is laid in a dish of 50% alcohol, changed once, to

* If the negative is required in a particular position, the film must be turned round before it is put on.

remove the chromium salts. The negative is then allowed to dry, and varnished.

Enlargement and Reduction.

For the preparation of enlarged or reduced negatives an enlarging apparatus, such as that shown in Fig. 57, is required. This consists of a camera with a movable middle board (Z), upon which the objective (B) is fastened. At *a* the plate to be enlarged or reduced is placed. C is the focussing screen.

The apparatus is directed obliquely to the sky, so that the plate *a* is evenly illuminated. It can also be used horizontally, and a white card or mirror placed in front to reflect the sunlight upon the plate.

In default of such an apparatus, put two cameras together, and throw a black cloth over the point of junction. The plate is then put in place of the focussing screen of one camera.

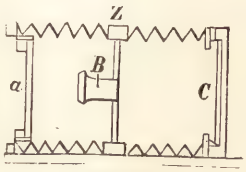

Fig. 57.

A diapositive is first prepared as described on p. 134. This is fixed at *a*, and all side light carefully kept off by means of black paper. The objective B then throws upon the screen C an enlarged or diminished image, which is focussed by drawing the screen in and out as in taking an ordinary photograph.

By using a gelatine or collodion plate in this way an enlarged or reduced negative is obtained.

If the distance of the central stop of the objective B from the diapositive *a* equals twice the focus of the objective, an image of the natural size is formed upon the focussing screen (see p. 60). By a less distance a greater image, by a greater distance a smaller, is produced.

In place of the diapositive, a negative also can be enlarged or reduced, and a negative made from the positive so obtained in the way described on p. 134, or that described under "Pigment Printing."

Enlargement by extension. The negative is laid in very dilute hydro-fluoric acid (10 parts of commercial acid in 200 parts water).* The film leaves the glass in a short time, and rapidly stretches itself. The stripped film is laid in clean water, and placed on a glass plate to prevent air-bubbles; then both are taken out and allowed to dry. A 6 × 8 cm. plate may in this way be enlarged to 9 × 12 cm.

5. RECOVERY OF SILVER FROM RESIDUES.

Only a small part of the silver contained in photographic plates is used for making the image; most of it goes away in the developer, washing water, and fixing-bath, and can be recovered from them with comparatively little trouble. The following solutions should be kept for the recovery of the silver :—

In the bromide of silver gelatine process. The fixing-bath. Spoilt plates should be fixed for the recovery of the silver.

Wet collodion process The used developer and intensifier, as well as the fixing-bath. The papers also which were used to filter and skim the silver bath.

Collodion emulsion process. The fixing-bath. Barrels covered with pitch, or large earthen jars, should be used to keep these solutions in. The fixing-baths should be kept separate from the other residues. The recovery is carried out in the following way :—

The *fixing-baths* are mixed with liver of sulphur

* Solutions of hydrofluoric acid must be used with care, or painful wounds may be produced It is best to cover the hands with rubber gloves.—*Translator.*

solution, and shaken up until a precipitate (of sulphide of silver) occurs. This precipitate is allowed to be deposited, the clear solution is poured off; it is put into a paper or linen filter, washed several times with water, and dried.

The developer and intensifier from the wet collodion process are allowed to stand until the separated powdered metallic silver is deposited, filter the latter, wash and dry it.

The *paper residues* are burnt, and the remaining ashes, which contain silver, collected.

The quantity of sulphide of silver so procured, and metallic silver in the ashes of the paper, are then handed over *separately* to a chemical factory for the recovery of the silver.

V.

POSITIVE PROCESSES.

To make a positive picture, a piece of sensitive paper is exposed to light under a negative. The light acts on the paper through the transparent parts of the negative, and so produces a positive picture (p. 5). It is necessary to bring the negative into the most intimate contact with the paper, or the prints will not be sharp. For this purpose, so-called printing frames are used (Fig. 58).

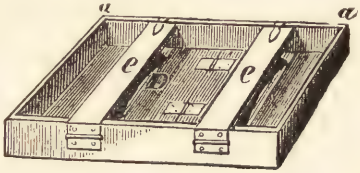

Fig. 58.

These consist of a wooden case *a a*, with a sheet of glass laid inside and a lid D, which is divided in the middle and furnished with hinges. This lid is held firmly down against the bottom with springs of the form seen at *e e*.

The negative is laid upon the glass (with the film upwards), and the sensitive paper placed (surface downwards) upon it; then a pad of paper or felt to equalise the pressure, and lastly the lid D.

For smaller plates a simple case without glass is enough. The plate lies in a groove of the wood. It is advisable to cover this groove with indiarubber, for negatives of curved glass easily break. There are many kinds of such printing frames on sale.

When it is desired to observe how far the printing has gone, one side of the frame is opened. This can be done without disturbing the print, as the lid holds its other half firmly.

Positive processes are divided into those which do not need development, that is, those in which the image is visible during exposure and developing processes. In the latter kind it is only faintly or not at all visible, and is first seen during later operations.

Positive processes without development include processes on albumen or salted paper, as well as printing-out processes on chloride of silver paper with gelatine or collodion.

Developing processes include bromide and chloride of silver gelatine developing processes, pigment printing, and platinotype. For beginners, printing-out processes are preferable to the others on account of their greater simplicity.

A. Albumen and Salt Paper.

The albumen process is the one most used in practice. The greater number of commercial photographs are on albumen paper. The sensitive paper is prepared, for which purpose ordinary albumen paper, that is, paper coated with an even film of salted albumen, is allowed to float upon a silver solution, when the albumen coagulates or becomes insoluble in water, and at the same time precipitates chloride of silver. Lastly, the sensitive substance is formed. Amateurs, to save themselves the trouble of "silvering," generally buy the silvered albumen paper of commerce, which

will keep. Paper silvered at home, however, gives better results (prints more harmoniously), and acts better than paper bought ready sensitised.

Salted paper is a paper which is covered with a film of starch containing cooking salt instead of albumen. It has a matt surface, while albumen is glossy. The operations are the same for both.

Silvering the Paper.*

Silver bath for positives. Dissolve 100 grms. = 1543 grs. of nitrate of silver in 800 c.c. = 28 ozs. of distilled water. This solution must always be neutral (must not turn blue litmus paper red); if it has an acid reaction, add a few drops of a 10% solution of carbonate of soda until a slight thickening is caused by shaking. A silver bath that has already been used must have its reaction tested before use, and treated with permanganate of potash in the way described on p. 115.

This bath is put into a clean glass or porcelain dish,† filtered and skimmed as on p. 115. The paper is then laid on it with the film side (which is easily distinguishable in albumen paper by the appearance) upon the silver solution. This operation is performed by taking the paper by two sides or edges, lowering the middle until it touches the bath, and then lowering both ends (see Fig. 59).

* The silvering as well as the further operations, may be carried on in a half-dark room or in bright yellow light. In the photo-chemical laboratory of the Royal Technical High School at Berlin, the windows of the rooms in which printing-out processes are performed are covered with chrome yellow. Gas and paraffin have no effect on albumen paper.

† A separate dish for each operation should be used in positive as well as in negative processes, as otherwise grave faults will ensue. The fixing dish especially should never be used for any other purpose, as the slightest trace of hypo. would completely spoil the picture.

In laying the paper on the solution air-bubbles generally get under it, and hinder the sensitising of the covered parts. Raise the paper at one corner with the help of a horn, glass or silver hook until the whole sheet can be seen, remove the bubbles by raising or lowering it, or by the light application of the little hook, and then dip the paper again. If it curls, breathe on it until it lies flat. Silvering takes one minute in summer, one and a half in winter. *Be on your guard to prevent the solution touching the back of the paper.*

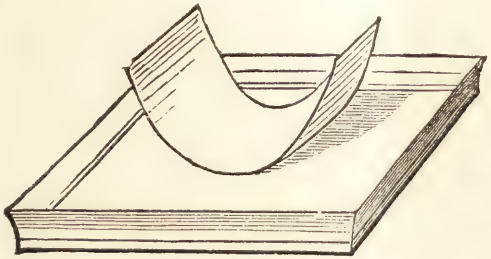

Fig. 59.

After sensitising the paper is raised by one edge (in order to spare the silver solution it may be drawn over the *clean* edge of the dish, or upon a glass rod laid across it), and hung up to dry in a half-dark room with the help of American *paper-clamps* (which may be obtained at any photographic dealers) strung upon cords.

Scrupulous cleanliness is necessary in silvering as well as in the following operations. Especially must every trace of hypo. be removed. *Also beware of touching the paper,* especially on the sensitive side, *with moist fingers,* as marks are easily caused.

The silvered paper must soon be used, as it quickly

becomes yellow. It keeps somewhat longer if laid in a printing frame, under slight pressure, between filter papers which have been soaked in a 10% solution of carbonate of soda, and then dried.

Printing.

The paper is cut up, when quite dry, into suitable shapes with clean scissors, and laid in a printing frame with the negative to be printed from as described on p. 144. *The glass side of the negative must be carefully rubbed before printing.* In using a frame with glass take care that no grit gets between the negative and the glass, or the negative is likely to break. The frame, covered with paper, is then exposed to daylight.* It is well to keep together the plates which take an equal time to print, if it can be arranged. It is then only necessary to regulate one of the frames, and so judge of the progress of all at once.

The exposure takes much longer than in negative processes. Dense negatives in dull weather often take a day, and sometimes the paper in the frame spoils before the picture is done. In such a case a piece of filter paper, moistened with a solution of carbonate of soda, is laid behind the paper, to prevent it from yellowing.

To observe the progress of the prints, take the frame into a room, open half of it in a not too bright place, while the other half still holds the paper tight, and look at the picture. *Take care not to disturb the paper in doing this.*

The printing is complete if the smallest details in the high lights are visible and the whole print is somewhat darker than is desired for the finished picture. This

* Flat negatives should be printed in very weak light, toned down by yellow paper over the frame; hard negatives in light as strong as possible (direct sunlight). Ordinary negatives are best printed in bright diffused light.

last is necessary because the prints always "go back" or grow paler in the gold and fixing baths. The proper degree of printing can only be determined by experience; it also depends on the character of the negative, of the paper, and the gold bath. Paper silvered at home fades in the bath less than the bought kind, and should therefore be less over-printed.

In order to produce *vignettes*, pictures softly fading into a white background, what are called *vignetting masks* are used.

These consist of a piece of dark card, in which a hole is cut resembling the shape which the picture is to assume.

The hole is cut smaller than the portrait, and this cardboard lid laid upon the frame, so that the hole comes over the figure to be printed.

The further the vignetting screen is placed from the negative the wider and softer will the graduated rim be, but the longer will the picture take to print. Care must therefore be taken that the card remains undisturbed and covers the frame entirely so as to admit no side-lights.

Vignetting masks of indiarubber, which are on sale in many sizes, are also useful.

Soaking the Prints.

The prints hold a considerable surplus of nitrate of silver, which must be removed by soaking before any further operations. For this purpose the prints are laid one upon another (the fingers must be perfectly clean) in a large *papier-mâché* dish with ordinary water, and immersed. The dish must be frequently rocked. The water will soon become milky by the formation of chloride of silver. After about ten minutes the water is poured off,* and the dish filled up with fresh

* The first water should be saved for the recovery of the silver it contains.

repeatedly until the water does not become milky. The prints are then ready for toning.

Toning.*

The soaked prints have a peculiar reddish colour. If they are fixed they assume an ugly brownish yellow tone. To avoid this the prints must be toned before fixing. This is best done in a much diluted gold bath called a toning bath. There are many recipes for it; one of the best is the

BORAX TONING BATH.

Sol. I.	Borax	7·5 grms.	= 116	grs.
	Distilled water	1000 c.c.	= 35	ozs.
,, II.	Double salt—chloride of gold and soda †	1 grm.	= 15	grs.
	Distilled water ...	50 c.c.	= 1½	ozs.

When required shortly before use, mix 200 c.c. = 7 ozs. Solution I. with 3 c.c. 50 mins. Solution II. for every sheet of paper to be toned.

Phosphate of soda may be used instead of borax. For silver paper made to keep, the following bath with acetate of soda may also be used; the paper, however, tones just as well in the former borax and gold bath:—

TONING BATH FOR COMMERCIAL SILVER PAPER.

Sol. I.	Borax	1 grm.	= 15	grs.
	Distilled water ...	1000 c.c.	= 35	ozs.
,, II.	Re-crystallised acetate of soda	4·5 grms.	= 69	,,
	Water	1000 c.c.	= 35	,,

* The operations of soaking, toning, fixing, etc., should be performed as soon as possible after printing, as it is not well to leave the pictures too long.

† Commercial chloride of gold is almost invariably the double salt.—*Translator.*

Sol. III. Double chloride of
gold and soda ... 1 grm. = 15 grs.
Distilled water ... 50 c.c. = 1½ ozs.

Mix 50 c.c. (1½ oz.) Solution I., 50 c.c. Solution II., and 4 c.c. = 67 mins. Solution III., for every sheet to be toned.

The toning bath is poured into a clean dish, which is best made of glass or porcelain, and then the washed prints placed in it *one over the other*, surface side uppermost. *The toning bath must cover all the prints equally, or marks will ensue; the dish should be continually rocked, and the position of the separate prints frequently changed.* The original reddish tone of the prints gradually yields in the gold bath to the ordinary colour of photographs.* Beginners may make sure of obtaining the right colour by making use of a completed photograph as a pattern.

If the toning bath is very cold it acts very slowly, so it should be slightly warmed. Commercial paper takes longer to tone than that silvered at home, and also uses more gold.

The prints do not generally all tone with equal rapidity. Those which have attained the right colour are dipped in a dish with ordinary clean water until all the prints are toned, and then all are fixed together.

FIXING.

Fixing bath :—
Hyposulphite of soda ... 100 grms. = 1543 grs.
Water ... ... 500 cc. = 17 ozs.

The toned pictures are dipped in the fixing bath *one after another. Care must be taken not to touch*

* The toning is best done in weak daylight, as it is difficult to judge of the colour by gas or yellow light. The process is caused by part of the silver contained in the prints uniting with the chlorine from the chloride of gold, to form chloride of silver, while metallic gold, which changes the colour, is deposited on the print.

unfixed prints with the hand that has been dipped in the hypo., or in a few days yellow marks will occur. The prints should be taken up singly with the left hand, placed in the fixing bath (without touching this with the hand), and then dipped with the right.

The prints remain in the fixing bath from 10 to 15 minutes; the dish must often be rocked. The fixing bath should be plentifully supplied, and renewed as often as possible. 5 grms. = 77 grs. of hypo. are reckoned to be used for a sheet of albumen paper, so that *at most* four sheets should be fixed in 100 c.c. of solution.

From the strength of the hypo. it is not advisable to use it up completely, for prints fixed in baths which have been too often used are likely to go yellow.

Toning and Fixing in One Bath.

Toning and fixing may also be carried on together in one bath. This process is simpler, and has the advantage (which should not be undervalued, especially by beginners) that it is easier to obtain the desired tone than with separate solutions, in which the colour of the picture alters somewhat in the fixing bath. For this, what is called the "combined toning and fixing bath"* is used, which keeps longer, and can be used repeatedly.† But the fault of a combined bath that has been used for a long time is that the prints are no longer sufficiently fixed in it, and therefore soon spoil. It is therefore advisable, in using old baths of this sort, to put the prints for a short time in the bath described on p. 151, to fix them more completely.

* For recipes see p. 158.

† The gold bath described above can only be used once and is then saved for the recovery of the gold.

Soaking and Drying the Prints.

After fixing, every drop of hypo. must be washed out of the prints, or they turn yellow after a short time.

The prints are put in a large vessel with water, which is changed at least ten times at intervals of about fifteen minutes. It is better still to wash the prints in running water for two or three hours; and there are washing apparatus on sale for this purpose.

The washed prints are hung to dry upon wooden pegs wound round with twine, or laid between clean filter papers, which must be changed several times while the prints are drying.

Finishing the Prints.

Trimming. The dry print is placed upon a glass or zinc plate under a glass pattern, such as can be procured of all photographic dealers, and cut evenly with a sharp penknife. They can also be cut while damp with scissors.

Mounting. The trimmed picture is put in water till it lies flat, and then laid between clean filter papers until it is but superficially moist.

They are then laid, image side downwards, one upon the other, on a piece of clean filter paper, and the uppermost print spread evenly by means of a bristle brush with *adherent starch paste.* It is then laid upon a card* of suitable size, covered with a piece of clean filter paper, and the print pressed flat with the hand, taking care that there are no air-bubbles between the paper and the card, and that the print is not folded. The paste is prepared according to the following directions :—

* With large prints it is advisable to moisten the cards with water on both sides, and to keep them piled up for at least an hour under pressure, so that they become equally moist. If this is left out the prints curl off during drying.

250 c.c. = 8 ozs. of water are heated to boiling point in a porcelain or enamelled iron dish. Pour in, while stirring, 20 grms. = 308 grs. of starch dissolved in as little water as possible, and allow it to cool.

Paste only keeps for a short time,* and after a few days loses its adhesiveness; it is always advisable to prepare it afresh. It should always be kept covered to prevent dust and grit from falling in. Paste which has become sour should not be used for mounting.

Retouching positives. The dry prints are retouched, that is, small marks which cannot be removed by retouching the negative (black marks on the negative appear white on the print) with colour.

Colours mixed with white of egg are used, and can always be obtained ready for use. The colours sold by Günther & Wagner in Hanover for retouching positives may be recommended.

Burnishing. The completed print, *well dried* † and retouched, is now, to give it a polished surface, burnished, that is, put under strong pressure through a pair of rollers, called a burnisher.

Before burnishing the prints must be wiped over with a cloth to remove adherent particles of dust. Prints on matt surface paper (such as salt paper) are not usually burnished.

Faults in the Positive Process with Albumen Paper.

1. *The image has double outlines.* Cause: The paper was moved when being examined.

* In warm weather it is well to add a few drops of carbolic acid.

† Prints which are not thoroughly dry remain adhering to the rollers of the burnisher.

Very glossy prints may be obtained by hot burnishing. Many forms of hot and cold burnishers are on the market, but cannot be further described here.

2. *Partial blurring of the image* occurs if certain parts of the paper were not in immediate contact with the negative.

3. *The image appears hazy.* Cause: The negative was placed the wrong way up in the frame (see p. 144).

4. *The picture is too hard* (too much contrast). Cause: Too hard a negative. Remedy: Print in bright sunlight.

5. *The image is too flat* (wanting in vigour). Cause: Too flat a negative. Remedy: Print in as dim light as possible (under tissue paper or a ground glass screen.)

6. *The paper adheres to the negative.* Cause: Varnish not dry enough, or paper moist.

7. *Unequal colour.* Cause: Too little gold bath, or insufficient rocking of the dish.

8. *Slow toning.* Cause: (*a*) Too cold, or (*b*) exhausted gold bath; (*c*) insufficient soaking of print before toning. Remedy: (*a*) warm the bath; (*b*) take a fresh gold bath; (*c*) the remedy is evident.

9. *Vein marks.* Too strong a gold bath or faulty paper.

10. *Large or small blisters* occur if the silver bath has a sour reaction, and sometimes even when this is not the case. Remedy: Neutralisation of silver bath, addition of ammonia to the fixing bath until it can faintly be smelt. Small bubbles generally disappear in drying.

A good method of avoiding blisters is the use of a second weaker fixing bath (10%), in which the prints are put for a short time before washing out.

11. *Yellow marks* occur if the print has been touched before or after fixing by fingers contaminated with hypo.

12. *The prints turn an ugly brown in the fixing bath.* Cause: Insufficient toning. Remedy: Additional toning in gold bath (see p. 157).

13. *The finished prints turn yellow.* Cause: (*a*) Insufficient washing out of the hypo.; (*b*) too old a fixing bath; (*c*) mounting of print with sour paste.

14. *The edges of the mounted print do not adhere to the card.* Cause: Bad paste.

2. POSITIVE PROCESS WITH CHLORIDE OF SILVER GELATINE AND COLLODION PAPERS (EMULSION PAPER).

The sensitive substances in chloride of silver gelatine and collodion papers are the same (chloride of silver and excess of silver nitrate) as in albumen paper, but they are held in a film of gelatine or collodion instead of albumen.

Both kinds of paper may be purchased ready for use, and keep a long time.

Their sensitiveness is greater than that of albumen paper, and they tone quicker. For this reason they are much used, especially by amateurs. Most emulsion papers have, however, the disadvantage that they make much harder prints* than albumen paper, and are therefore not so suitable to use with vigorous negatives; they are more fitted for thinner or somewhat flat negatives.

Chloride of silver gelatine paper (aristotype) is most used; it is on sale in good quality by many firms (Bütter, Herzheim, Liesegang, Stoltze, etc.). Chloride of silver collodion paper has still more recently come into use. The flat, highly glazed surface of this paper is of advantage in reproducing the details of the negative.

The *printing* is performed in the same way as with

* Under the name of Portrait and Mignon paper, softly printing chloride of silver gelatine paper has been recently introduced.

albumen paper. The prints must, however, be rather more over-printed, as they lose much in toning and fixing. The toning process is somewhat different.

Toning Chloride of Silver Gelatine or Collodion Paper.

The prints are soaked in the way described on p. 153, then toned in a sulphocyanide of gold bath of the following composition:—

SULPHOCYANIDE OF GOLD BATH.

Sol. I.	Distilled water ...	1000 c.c.	=	35 ozs.
	Sulphocyanide of ammonia	20 grms.	=	308 grs.
	Hyposulphite of soda	1 gr.	=	15 ,,
,, II.	Distilled water ...	100 c.c.	=	$3\frac{1}{2}$ ozs.
	Chloride of gold ...	1 grms.	=	15 grs.

For use, mix 100 parts of Solution I. with 10 parts Solution II.,* and 50 to 100 parts of distilled water. The mixed bath keeps for a long time, and can be used repeatedly. *The prints are toned in the way described on p. 150, until, in looking at them, they appear slate-colour, and in looking through them they have the desired tone,* and are then fixed according to p. 151.

In the fixing bath the grey colour fades quite away, and the prints assume a brown or very dark blue colour. On account of this alteration of tone in the fixing bath it is not always easy to get the right colour. The use of a combined toning and fixing bath is therefore advisable, as then the desired colour is always obtained.

* Solution II. is to be poured into Solution I., not *vice versâ*.

COMBINED TONING AND FIXING-BATH.

Distilled water	2000 c.c.	=	70 ozs.
Hyposulphite of soda ...	500 grms.	=	7716 grs.
Sulphocyanide of ammonium	55 „	=	848 „
Acetate of lead	20 „	=	308 „
Powdered alum	15 „	=	231 „
Citric acid	15 „	=	231 „
Nitrate of lead	20 „	=	308 „

This solution should be allowed to stand for some days; it is then filtered and mixed with 150 c.c. = 5 ozs. of solution of chloride of gold (1 to 200).

This combined bath will keep, and may be used repeatedly (after filtration), until it does not tone sufficiently.

The prints are toned in it until they assume the desired colour.* It is not absolutely necessary to wash the prints before use; but the practice is much to be recommended, as then the bath remains fit for use much longer.

Combined baths work when quite fresh more quickly than those which have been used for some time; it is therefore of advantage to mix a new bath with part of an old one.

Washing the Prints, and Treating them with Alum.

The fixed prints are well washed in the way described on p. 153, and then hung up to dry.

Prints on aristotype paper must, after ½ to 1 hour's washing, be laid for five or ten minutes in a bath (which may be frequently used) of 10 grms. (154 grs.)

* It is advisable to put the prints in a fixing bath (1 to 15) after toning, especially if an old bath is used.

chrome alum in 200 c.c. (7 ozs.) of water, to harden the gelatine. Then wash them again for an hour.

Finishing the Prints.

The prints are trimmed, mounted, retouched, and burnished, as described on p. 153.

Prints with a *high polish* are obtained by moistening the dried prints again, and squeezing them while wet upon a glass covered with a solution of wax, or rubbed over with talc.

1 grm. (15 grs.) of yellow wax is dissolved in 250 c.c. (8 ozs.) of benzine; a few drops are poured upon a thoroughly cleaned glass plate, and this is rubbed thoroughly with a piece of flannel until the plate is polished.

This plate is laid in a dish of water, and the print laid upon it, image side downwards, guarding against air-bubbles. Then both together are lifted out of the water, laid upon the blotting-paper; the water and possible air-bubbles are removed by means of an indiarubber squeegee going over the print several times.

After thorough spontaneous drying, the print can easily be taken off if the corners are carefully lifted with a knife, and the print drawn up from them. In the same way matt-surface prints may be obtained by using ground glass.

The *mounting* of these glazed or matt-surface prints takes place in the following way. Smear the print while still adhering to the plate in a half-damp condition with 5% gelatine solution, and let it thoroughly dry.

After taking it off, moisten the back with a sponge or brush, and press the print upon the card. The surface must not be wetted, or the glaze will be destroyed

Transparencies on Chloride of Silver Gelatine or Collodion Plates.

Very beautiful transparencies may also be prepared by means of the chloride of silver gelatine and collodion processes.

Transparencies on opal glass are especially beautiful. Transparent and opal glass may be purchased prepared with chloride of silver and gelatine, or collodion.

The operations are the same as with paper prints, only these must be still more over-printed.

The progress of printing on printing-out plates cannot be followed in a convenient manner by the use of ordinary frames. There are, however, on sale folding frames specially made for this purpose.

According to Dr. A. Miethe, very beautiful transparencies may be made by the help of chloride of silver collodion paper, by applying the collodion film to glass in the following way:—

The glass plates upon which the print is to be placed are washed clean, and covered while wet* with a filtered solution of the following composition, and dried in a horizontal position:

Gelatine	3·5 grms.	=	54 grs.
Alum	0·2 „	=	3 „
Distilled water	100 c.c.	=	4 ozs.

The gelatine is first left for a quarter of an hour in a beaker or bottle to swell, and then dissolved by placing the latter in warm water. After complete solution the alum is added. The solution must be kept warm, as it forms a jelly when cold.

Now print on ordinary chloride of silver gelatine paper, so deep that the high lights of the print begin to appear bluish (in making prints on opal glass do not print deeper than for an ordinary paper print),

* In the way described on p. 111.

so that the picture cannot be seen in looking at it, and is only visible by looking through it.

The print is toned according to above directions, fixed, and washed for a short time.

It is then placed in a porcelain dish, rather larger than itself, and boiling water poured over it. After about two minutes the collodion film becomes detached from the paper, and the latter is removed.

After the water is thoroughly cooled,* put it upon the glass plate (which has been previously prepared as given above), with the film side up, and spread out the collodion film with a soft brush, guarding against air-bubbles, so that the paper side is turned upwards.

Then take up the glass plate with the print upon it, let the surplus water run away, and lay the whole horizontally to dry.

After thorough drying, remove the adherent baryta film by means of careful rubbing with a moist pad of wool or cloth.

Developing Printed Chloride of Silver Gelatine or Collodion Prints.

Instead of printing chloride of silver emulsion paper or plates until the image has the requisite strength, it is possible, according to Valenta, to print them only till a weak image is visible, and then to develop them to full strength.

In a good light about half a minute's printing is enough, under a clear negative. Then develop in the bath described below, which may be used over and over again:—

Distilled water ...	1000 cc.	=	35 ozs.
Crystallised sulphite of soda	100 grms.	=	1543 grs.
Citric acid	11 „	=	169 „
Pyrogallic acid ...	10 „	=	154 „

* The gelatine film dissolves off the glass in warm water. The cooling may be hastened by the addition of cold boiled water.

Chloride of silver collodion paper should be put into the bath dry; gelatine paper should be previously washed for a short time.

After the development is finished the prints are placed for some minutes in a dish of water, and then toned in the combined bath.

The process of development gives prints which cannot be distinguished from those directly printed out, and has the great advantage that prints may be obtained in a short time in very dim light. It is not, however, so sure a process as direct printing, as the pictures are not always equal, and sometimes come out patchy in spite of the utmost care.

Preparation of Chloride of Silver Collodion Paper.

Although collodion paper of good quality is on sale, it may be as well to give short directions here for its preparation in small quantities, as it is comparatively simple.

According to Niederstädt, 1·5 grms. (23 grs.) of lithium chloride and 1·5 gr. citric acid are dissolved by warmth in 50 c.c. (1½ ozs.) of 96% alcohol, and the filtered solution added to 500 c.c. (17 ozs.) of 4% raw collodion. Then 14 grs. (216 grs.) of nitrate of silver are dissolved by heat in a test tube in 7 c.c. (¼ oz.) of distilled water, 150 c.c. (5 ozs.) of 96% alcohol added, and heated to boiling point, so that no nitrate of silver remains undissolved.

The silver solution is then poured, a little at a time, into the collodion, with continual shaking, and finally 4 to 6 grs. (62-93 grs.) of pure glycerine added.

The collodion may be used a quarter of an hour after preparation, and keeps a long time in the dark. If it has stood for a long time it should be well shaken before use, to distribute the chloride of silver

which has sunk to the bottom, and should then be left to stand for a quarter of an hour.

Ordinary baryta paper is then coated with this collodion in the way described on p. 116 under collodionising.

For this purpose small pieces of paper may be stretched tight in a printing frame; in order to coat a whole sheet a *pouring frame* is used, and is on sale.

After drying, the paper can be used immediately, but only keeps for a few weeks.

Faults in Emulsion Processes.

1. *Ugly green tones* are assumed by the print in a combined toning and fixing bath that has been kept too long.

2. *The prints stick to the filter paper in mounting.* Cause: Insufficient alum.

For other faults see under "Albumen Processes."

3. Positive Process with Chloride of Silver Gelatine Paper with Development.

The process without development described on p. 156 is based upon the fact that with an excess of nitrate of silver gelatine, containing chloride of silver, turns dark brown in light. If the paper with gelatine and chloride of silver is prepared without an excess of silver nitrate, it will give but a very weak picture by direct printing; but if it is exposed for a short time, and then developed, as vigorous a print is obtained as by direct printing.

Chloride of silver and gelatine developing paper keeps for a long time, and can be bought ready for use.

It has the advantage, too, that prints with warm tones, like albumen paper, may be obtained in bad weather. It is, however, difficult to prepare a number

of prints of similar colour, as the latter depends on the time of exposure.

Printing upon Gelatine Chloride of Silver Developing Paper.

The paper should be placed in the printing frame, as well as developed, in the dark room by yellow light.

The duration of the exposure depends upon the density of the negative and the colour desired.

Short exposure and strong developer give black pictures; long exposure and weak developer redder ones. Expose in diffused daylight under a normal negative.* For black pictures ½ second; for sepia prints 1 second; for reddish-brown 2 seconds; for bright red ones 3 seconds.

A proportionally longer exposure to gaslight is necessary. 1 second of daylight is equal to about 30 to 40 seconds of gaslight (with a bat's-wing burner) at ¼ of a yard distance from the printing frame.

Development, Toning, and Fixing of Chloride of Silver Gelatine Prints.

The most suitable developer is eikonogen, according to the following directions:—

Eikonogen Developer for Chloride of Silver Gelatine Prints.

Sol. I. Eikonogen developer, according to the first recipe (p. 83).

„ II. Distilled water ... 200 c.c. = 7 ozs.
Bicarbonate of soda ... 10 grms. = 154 grs.

* Only approximate estimates can be given here, as the intensity of daylight varies very much, and the sensibility of the paper is not always the same.

For use, they are mixed thus:—For sepia and reddish brown prints 100 parts Solution II., 40 parts Solution I., 2 drops 2% potassium bromide; for bright red prints, 100 parts Solution II., 20 parts Solution I., 1 drop of bromide; for black prints use Solution I. alone, with the addition of 5 drops of bromide to 4 ozs.

The paper should be laid before development for a short time in water till it lies flat; it is then developed in a dish.

When the print appears to be of sufficient strength it is taken out and fixed for ten minutes in a 10% solution of hypo., and is then further treated like a direct print (see p. 156). If albumen colours are desired, the red or reddish-brown pictures must be toned in one of the gold baths * given on p. 157, after being developed and *well washed*. Black and sepia prints are not toned.

Washing, Soaking in Alum, and Finishing the Prints.

All this takes places in the same way as the direct printing process described on p. 158.

Preparation of Transparencies on Chloride of Silver Gelatine Plates with Development.

Chloride of silver gelatine plates are especially suitable for making window transparencies and lantern slides, on account of their great clearness.

The operations are the same as with paper prints, only the print should be examined in development by looking *through* it.

Chloride of silver plates can be obtained commercially.

Chloride-bromide of silver plates give good results;

* The combined toning and fixing bath is most suitable.

they are more sensitive than those containing only chloride of silver.

4. POSITIVE PROCESS ON BROMIDE OF SILVER GELATINE PAPER.

Paper is prepared with the gelatine bromide of silver used for negatives, and thus an exceedingly sensitive paper is obtained, upon which positive pictures may be produced in a very short time by exposing to gaslight for a few seconds, and then developing. These prints are black, and resemble platinotype, for which they are often sold.

Bromide of silver gelatine paper is issued in good quality by different firms; it keeps for a long time. The pictures produced by it are permanent, provided that great care is exercised in washing out the hypo.

PRINTING ON BROMIDE OF SILVER GELATINE PAPER.

The paper is laid on the printing frame in the dark room *by red light.* It is then placed from half a yard to a yard distant from a gas or paraffin lamp, protected by a card, and exposed for some seconds.

About six to ten seconds are necessary for an ordinary negative, half a yard away from a bat's-wing gas-burner.* By a short exposure a print of great contrast is obtained; by a long exposure a soft print. By over-exposure the prints assume an unpleasant greenish colour.

This green tone disappears if the print is placed in a good gold bath (best of all, a combined toning and fixing bath).

DEVELOPING AND FIXING THE PRINTS.

Eikonogen developer, according to the first recipe

* The sensibility of different kinds of bromide of silver paper can hardly be determined.

(see p. 83), with the addition of a few drops of 10% solution of potassium bromide, is most suitable.

The exposed print is soaked in water till it lies flat, and then developed in a dish. *As soon as the print shows sufficient strength* it is rinsed with water*, and fixed for five minutes in the acid fixing bath given on p. 83.

Rodinal much diluted (1 to 100) is also suitable as a developer.

Washing, Alum Bath, and Finishing the Prints.

These operations are exactly the same as in the chloride of silver gelatine process (see p. 158).

Making Enlargements on Bromide Paper.

Bromide paper allows of the preparation of enlargements in the simplest way without first making an enlarged negative.

The negative to be enlarged is placed in the apparatus described on p. 141 (see Fig. 57), and focussed upon the ground glass screen to the desired size.

Then a similarly sized piece of bromide paper is stretched on a board by means of drawing pins, and is placed in the dark slide instead of a plate.

The time of exposure depends on the degree of enlargement, as well as the light transmitted by the objective and the weather.

By development an enlarged positive is obtained.

Or else the negative is placed in a magic lantern, and focussed (of course in the dark room) upon a drawing board covered with strained white paper, then (after the objective is closed) a sheet of sensitive bromide paper is placed where the image came, and expose. Special enlarging apparatus are made for

* The prints should not be over-developed, as they lose nothing during fixing.

this purpose, with magnesium or Zirconium light, by which enlargements to any desired size may be made with a comparatively short exposure.

In enlargement it is necessary to cut off all side lights; light which goes through the negative obliquely will fog the whole print.

Making Transparencies on Bromide Plates.

In preparing transparencies bromide plates of not too great sensitiveness, and as *clean working as possible*, should be used. Less sensitive plates give prints of smaller grain, and clearer than highly sensitive ones do. All operations have been already described on p. 134.

Brown Colouring of Bromide Prints.

The black colour of bromide prints can easily be turned into a pretty sepia brown by putting them for a short time in the uranium intensifier described on p. 95, and then washing them carefully.

The washing should not be carried on too long, or the brown colour will fade away again.

Faults in Bromide Prints.

1. *The prints have no pure whites.* Cause: Too strong developer or too little potassium bromide; too long exposure or development; too thin a negative.

2. *The paper blisters.* This fault sometimes happens in warm weather. Remedy: Put the prints in alum, after fixing and washing. Cool the developing and fixing baths.

Other faults in bromide positive processes are the same as in negatives (see p. 106).

5. Pigment or Carbon Printing.

The pigment process depends on the property of gelatine of losing its solubility in hot water, on

exposure to light in the presence of chromium alts.

Consequently, if paper is covered with gelatine in which is any desired pigment or colouring matter, and the same made sensitive to light by immersion in a solution of bichromate of potash, and, after drying, exposed under a negative, the parts acted upon by light remain unchanged when the paper is treated with warm water, and a positive picture is obtained.

But since the tender parts of the picture lying on the surface, such as the half-tones, where the light has not acted upon the whole thickness of the paper, are likely to disappear in such a washing, it is necessary to apply the gelatine film to another surface before "development."

Pigment printing has the advantage over silver printing of producing pictures which never bleach, because they are made of fast colouring matter, and have the further advantage of freedom in the choice of colour, as the gelatine film which serves as the ground of the picture may be mixed with any pigment. But unfortunately the pigment prints are much more susceptible to mechanical injury than silver pictures.

Carbon tissue, the material upon which the printing is carried out, is to be purchased in all colours.*

It is usually sold in rolls. Caution is necessary in unrolling it, as the pigment film easily breaks when very dry. It is best to fasten the end of the roll to a table with drawing pins, and then unroll as much paper as is required. The piece (cut off with a sharp knife) is best put under pressure, to make it lie flat.

* Pigment paper is manufactured by the Autotype and Woodburytype Companies, London. For a first trial it is advisable to procure a pattern book which gives samples of different kinds of pigment paper.

Sensitising Carbon Paper.

*Sensitising bath.** Dissolve 4 grms. (62 grs.) of bichromate of potash or soda (acid chromate of potash or soda) in 100 c.c. (4 ozs.) of distilled water, filter into a dish, and dip the pigment paper (film uppermost) completely under with the hand, by yellow or lamplight. First rub it over with a clean cloth to remove dust.

The curved roll soon becomes flat; it is then turned

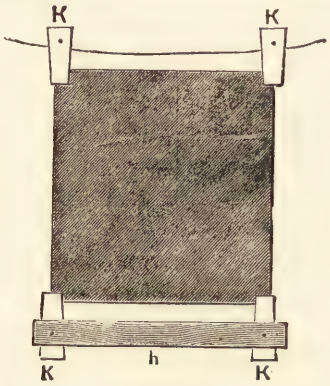

Fig. 60.

round and dipped in the chromate bath until it seems to glide between the fingers. An immersion of one minute is enough.

Drying the Sensitised Pigment Paper.

Small sensitised pieces may be hung upon paper-clips without further trouble, a clip to each upper

* In very warm weather the bath must be cooled with ice to prevent the film of gelatine from dissolving in the bath.

corner. It is advisable to fasten the two lower corners by clips attached to a cross piece of wood. These prevent the sheet from curling in drying.

Large sheets, after being taken out of the bath and drained, are best laid upon cardboard covered with a piece of filtre paper. The cardboard is then bent so that the paper lies convexly, and laid over a stick. After an hour the half-dried sheet may be hung up as above.

The drying room must be clean, free from dust, dark, airy and cool in summer. Daylight is not admissible. Paraffin or gaslight do no harm.

The drying should not last too long, or the paper will decompose before it is dry. Paper which has been longer than 12 hours drying can be assumed to be half decomposed. The prepared pigment paper lasts four or five days, but works best when fresh. It should be kept under pressure (in the printing frame) to make the sheet lie flat.

The sensitising bath should be kept in the dark. It may be used repeatedly until it assumes dark brown colour.

Prints in which great sharpness is required—transparencies which are to be enlarged, for instance—may be squeegeed upon glass which has been dusted clean, and well rubbed with talc, and so dried. After it is quite dry the paper should be cut round the edge and removed from the glass. The paper acquires a high polish by drying on glass, and remains perfectly flat. It therefore lies flat against the negative in printing, and a very sharp print is obtained.

Printing on Carbon Paper.

Negatives which print well by the silver process do the same with carbon paper. Flat negatives seldom give good results. The negative should be

provided with a narrow black edge,* either by mounting it on black paper, or spreading black varnish on it. This is done to protect the rim of the paper from exposure; it then does not frill in development.

The paper is laid in the frame in the way described on p. 144.

In printing pigment paper an *actinometer* is necessary, as the image is invisible upon the black surface.

H. W. Vogel's Actinometer. This instrument (see Fig. 61) consists essentially of (1) a semi-transparent

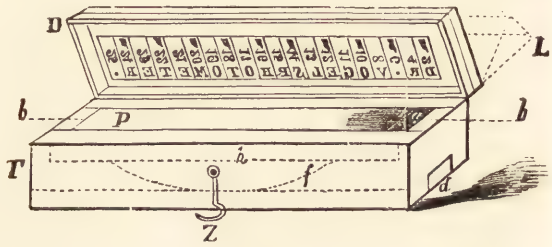

Fig. 61.

paper scale, the transparency of which increases gradually from one end to the other, and (2) a sensitive piece of bichromate paper, which will keep for a week, and is exposed to the light under the scale as silver paper is under a negative.

This actinometer is prepared in the following way:—

Dip Saxe's or Rive's paper, cut up into eighths of sheets, by lamplight for one minute in the same solution which is used in sensitising carbon paper, and then hang it up to dry spontaneously. The actinometer paper is

* If a printing frame without a glass, described on p. 144, is used, no black edge is necessary, as the groove in the frame covers the edge of the negative.

made of pigment paper before sensitising. The paper so prepared may be kept in a dry, clean, light-tight wooden box, kept clean, for four weeks without change.

The dried paper is cut up into strips, and the box *T* of the actinometer filled with it. A spring *f* presses the strips down by means of a block of wood *P*, when the lid *D* is shut, against the transparent scale which rests in the glass lid *D*, which is shut by means of a hook *Z*.

In exposure the light shines through the semi-transparent scale, and turns the underlying strips brown. This colouring proceeds from the thin to the thick end of the scale, and goes on more quickly the stronger the light is. In order to judge how far the action of the light has proceeded towards the thick end, black marks and figures are drawn upon the scale; these do not let the light pass through, and, when the bichromate paper all round is fixed, appear white upon a brown ground.

If the actinometer is opened by lamplight and the bichromate paper observed, the place up to which the light has acted, and the number visible there, is observed.*

This instrument is brought into daylight at the same time as the negatives to be printed. After some time cover up the negative, take the actinometer in, and observe by lamplight what figure it has obtained. An ordinary negative is printed enough if the number 17 is faintly visible.† The printing proceeds somewhat quicker than the albumen process, and is, in a good light, completed in a few minutes.

* The eye must be protected from the light as much as possible in reading off the actinometer.

† An exact estimate cannot be given, as the sensibility of different papers is not the same. The above is reckoned for English pigment paper.

Transfer and Development.

SIMPLE TRANSFER UPON PAPER.

A. *Squeegeeing.* A piece of *ordinary transfer* paper * is cut, somewhat larger than the picture which is to be developed; this is then put together with the pigment paper in *cold water* (cooled with ice in very hot weather)—any air-bubbles rising out of the pigment film must be removed by rubbing with the fingers—then after a minute they are placed together, so that both the prepared surfaces touch each other; by this means air-bubbles are prevented. Both sheets are now laid on a plate of zinc, glass, or slate, the transfer paper underneath, and flat upon them a somewhat

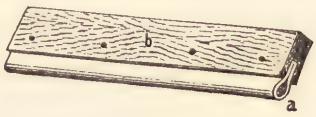

Fig. 62.

larger piece of oiled silk. Hold the papers firmly on the left side with the thumb and finger of the left hand, and then go over the paper with a wet squeegee [Fig. 62, a ruler (*b*) with an india-rubber edge (*a*)] several times with a strong even motion without stopping; then remove the silk and hang up the papers, now squeegeed together, for five minutes or longer.

Pigment paper easily rubs up while lying in water, and the fibres are apt to get between the pigment and transfer paper; it is therefore well to pour away the dipping water before the transfer, and to put the paper in fresh water.

* A paper coated with coagulated gelatine, which may be bought ready for use.

B. *The development.* Meanwhile a good-sized dish of zinc or sheet tin, filled with water, has been heated up to 40° or 50° C., and the papers, pressed together, immersed in it.

The coloured gelatine soon begins to loosen and to pass out between the papers, and the original carbon paper becomes raised. By touching the edges with the fingers it is easy to find out the exact time when it is quite loose, then it can be removed. The transfer paper is held fast by one corner, and the pigment paper taken from off it by the same corner; the film is now supported by the transfer paper. This paper is now laid upon a plate of glass, and warm water sprinkled over it with the hand to hasten the development. The gelatine that still adheres soon dissolves away, and the picture appears clearer. It is then left in water till no more coloured gelatine runs off in washing.*

If the picture is too light it was exposed too short a time; if too dark the exposure was too long. Under-exposed prints should be developed with colder water, while it should be used hotter for over-exposed ones. The wet print should not be touched with the fingers, as the pigment film is excessively easily damaged.

C. *Pressing, drying and finishing.* After development the prints are washed in cold water, and then laid for a quarter of an hour in a 4% alum solution to harden them; they are then washed in cold water and finally dried.

This simple transfer process produces prints *reversed* from the negative; it is therefore, roughly speaking, only used for reversed or film negatives, which may be printed from either side.

* Particular parts of the picture may be brightened by pouring a stream of hot water out of a squirting flask on them.

Pictures may be produced in their proper position by means of the double transfer process.*

Simple transfer process on glass. The pigment process is also very suitable for the preparation of transparencies. All the operations are the same as for paper prints, only the paper must be printed much deeper (up to 25°, or higher).

The glass plate is first prepared with the following gelatine solution, to cause the paper to adhere better †:—

Chrome gelatine solution: Soak 15 grms. (231 grs.) gelatine in 300 c.c. (11 ozs.) of distilled water (for about half an hour), and dissolve it by setting the vessel in warm water (140 F°.). After the gelatine is *quite* dissolved, add, drop by drop and shaking all the time, a 6% solution of chrome alum until the solution begins to thicken (6 or 7 grms. (93-108 grs.) will be necessary). Then drop acetic acid in (still shaking) until the solution becomes fluid again; a surplus of acetic acid is to be avoided as much as possible. Keep it warm, and filter through moistened flannel before use.

Clean glass plates are covered with this solution and dried. The plates so prepared will keep.

Double Transfer Process with Developing Paper.

The double transfer process gives pictures the right way round.

The procedure is as in the simple transfer process,

* It is advisable for beginners to practise the simple transfer process first.

† The customary preparation of the plate with collodion is not to be recommended, as the film is apt to leave the glass. Many pigment papers (Braun's transparency paper, for instance) need no previous preparation, but adhere firmly to the glass without it.

with the exception that the print is not applied to simple transfer paper, but to a temporary support, the "developing paper," which may be bought ready for use. A few hours before use the paper is rubbed *thinly* by means of a rag with resin solution of the following composition :—

Powdered resin ...	3 grms.	= 47 grs.
Yellow wax	1 „	= 15 „
Turpentine	75 c.c.	= $2\frac{1}{2}$ ozs.

It is developed, washed, and put in an alum bath as in the simple transfer process.

The transfer. Cut a piece of ordinary double transfer paper, somewhat larger than the print to be transferred, and dip it in clean warm water of 98° F. until it feels slippery. It is then put in cold water and placed (under water, guarding against air-bubbles) with the film in contact with its prepared surface. Both papers are then taken out, gone over with the squeegee not too violently, and hung up to dry at the ordinary temperature. The dry picture then either comes spontaneously off the developing paper, or allows itself to be taken off easily.*

To make the picture obtained capable of withstanding moisture, rub it with resin solution (see above) with flannel. The developing paper can be used again after rubbing with resin.

The squeegee, as well as the oiled silk, must in double transfer be very carefully cleansed of every trace of chromium salts, or the pictures will have yellow marks.

Double transfer process with glass. In place of the developing paper, a glass plate covered with collodion may be used for a temporary support. Pictures with a *high polish* are then obtained. Rub the cleaned

* Pictures developed on ordinary transfer paper cannot be transferred

glass plate (opal-glass is best) well with talc, and after dusting, coat it with 1% raw collodion in the way described on p. 116. As soon as the film has set (not dried), dip the plate in cold water* to avoid greasy stripes. The print is then squeegeed, developed, etc., in the ordinary way. The transfer of double transfer paper is performed in the same way.

Mounting and Retouching the Pigment Prints.

Mounting and retouching is done in the way described on p. 153. *But the prints should not be wetted*, as the film is easily damaged. Especially in mounting is great care necessary, on account of the ease with which the prints are injured. To mount the prints with a high polish see p. 159.

Pigment Printing on Mica.

Thin plates of mica have recently been introduced for pigment printing, covered with coloured gelatine in the same way as pigment paper.

These mica plates are sensitised by immersion in a solution of bichromate of potash, and printed like pigment paper. *In printing care should be taken to turn the mica side to the negative, not the pigment side.*

After the printing is done it is developed *without previous transfer.*

Pigment pictures on mica have the advantage over glass of greater brightness; they are also unbreakable, and take up less room.†

Faults in Pigment Processes.

1. *The pigment paper does not adhere to the transfer*

* The plates should be allowed to lie in water until required.

† Celluloid is more generally used in England.—*Translator.*

paper, or developing paper. Cause: Pigment paper soaked too long.

2. *Edge of the picture dissolves in development.* Cause: No black edge to negative.

3. *Folds and stripes* occur through uneven squeegeeing.

4. *Round white marks* appear if, in the transfer, air-bubbles got between the pigment and transfer paper.

5. *The gelatine film does not dissolve in the developing bath.* Cause: Great over-exposure of print, or old decomposed paper.

6. *Little blisters appear in the print.* Cause: Faults in the paper.

7. *The pigment film shows worm-like wrinkles.* Cause: Bichromate bath too warm, or paper dried at too high a temperature; but sometimes the reason lies in the pigment paper. Deeply printed pictures (on glass) show this fault oftener than shortly exposed ones. Remedy: Cool the chromium bath with ice.

8. *Flat prints* are caused by thin negatives. Remedy: Sensitise the pigment paper in a diluted bichromate bath (2 grms. (31 grs.) bichromate of potash, 100 c.c. (4 ozs.) of water). Very thin negatives are not suitable to pigment printing.

9. *Pictures are too hard* if the negative has too strong contrasts. Remedy: Cover the negative with matt varnish, and stop out the places which print too light.

10. *The double transfer paper does not come away from the developing paper.* Cause: Developing paper not rubbed with resin.

11. *Blurred places* occur in the print if the pigment paper is not applied evenly. Remedy: Strengthen the hold of the printing frame by laying blotting-paper in it, and keep the pigment paper under pressure until it lies flat.

6. PLATINOTYPE WITH DEVELOPMENT.*

Paper is prepared with a solution of chloro-platinite of potassium and ferric oxalate, and exposed under a negative; in the exposed parts the ferric oxalate changes into ferrous oxalate. The paper is then floated upon a hot solution of oxalate of potassium, and the ferrous oxalate dissolves and reduces the chloro-platinite of potassium to metallic platinum. Thus a black platinotype is obtained.

The platinum process gives matt-surface pictures which resemble copper-plate engravings, and are therefore very artistically graduated. They have the advantage of absolute permanency. Platinotype paper is on sale in good qualities, but it can easily be prepared according to the following directions.

PREPARATION OF THE PAPER.

Strong unsized photographic paper † is treated with a preliminary preparation of gelatine or arrowroot ‡ to close the pores, so that the picture should not sink into the substance of the paper. *Arrowroot* is best, as the platinotypes produced on gelatine paper turn yellowish unless washed with great care.

Two grms. (31 grs.) of arrowroot are rubbed into a little water in a dish, and then poured into 100 c.c. (4 ozs.) of boiling water, shaking all the time. The thin paste so obtained is pressed through linen.

* The Platinotype Company, of Southampton Row, supply all requisites for this process.—*Translator.*

† Paper made blue with ultramarine should not be used, as the hydrochloric acid used in fixing the image turns it yellow. The Rives factory has introduced paper specially prepared for platinotype.

‡ Paper may be bought prepared with arrowroot. Salted arrowroot paper, called salt-paper (p. 146), is not to be used for platinotype.

The paper is stretched on a drawing-board or clean table, and the above solution applied by means of a bristle brush,* and spread equally with a "distributing brush." After drying it is covered once more. ½ to ¾ oz. solution is necessary for each coating of 1 sheet of paper, 18 × 23 ins. The following operations (sensitising, developing, etc.) should be carried out by lamplight, or yellow and very weak daylight.

Sensitising the Paper.

Formulæ for sensitising solutions.

Sol. I.	Chloro-platinite of potassium ...	10 grs.
	Distilled water	60 c.c.
„ II.	Ferric oxalate solution for platinotype†	
„ III.	The above ferric oxalate sol. ...	100 c.c.
	Chlorate of potassium	0·4 grs.

All three solutions are filtered. Solutions II. and III. are very sensitive to light, and must therefore be kept in the dark or in a black bottle.

Immediately before use 4 parts of Solution III. are mixed with 7 of Solution II., 12 of Solution I., and 2 c.c. of distilled water. If more is taken of Solution III. and comparatively less of Solution II. paper is obtained which gives harder prints and *vice versâ*. The proportion given above is reckoned for ordinary negatives.

Sensitising the paper. The prepared and dried paper is stretched upon a clean drawing-board, and spread with the sensitising solution by lamplight or very faint daylight. For every sq. ft. of surface of paper 50 mins. of solution is necessary. As in the

* A brush of what is called "smooth bristles" should be used.

† The solution is sold under this name by Schering the chemist. It is not possible for any but chemists to prepare it at home.

first preparation, two brushes are used, one for applying it and one for equalising it.

Neither should be cased in metal, and must be carefully washed with distilled water immediately after use.

The coated paper is then *immediately* dried in a drying cupboard at 86° or 104° F. A large box or a

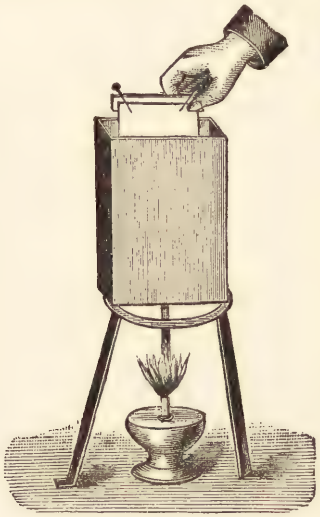

Fig. 63.

wooden frame, with card nailed on to it, may be used as a drying cupboard.

A piece of tin is nailed on for a bottom. The lid consists of linen stretched on a frame. The box is warmed by means of a gas or spirit lamp placed under the tin bottom. The temperature is ascertained by means of a thermometer put through an opening in the side.

The paper is laid horizontally in the box upon canvas stretched on wooden frames.

The drying cupboard described on p. 138 is very suitable for the drying of platinotype paper.

For this purpose a wooden frame covered with stretched canvas is used. If the paper dries too slowly the solution sinks among its fibres, and the prints obtained lack vigour; they must dry in 10 minutes at most.

According to E. Krause, platinotype paper can be dried in the following manner:—

Lay upon a sheet of tin that is not too thin a prepared box (see Fig. 63) which has one small side open; the size of the box should be so arranged that the largest print likely to be taken goes into it comfortably. For instance, 3 × 6 × 11 ins. is a very fair size for 5 × 8 ins. prints. To prevent burning the paper, care should be taken that the box is at least 6 cm. higher than the paper is long.

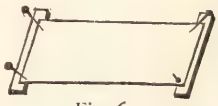

Fig. 64.

This box is placed on a tripod and heated by a gas or spirit flame. The preparation of the paper may begin as soon as the iron of the lower half of the box hisses when touched with water.

Two pieces of wood 10 cm. long are then cut, so that they can easily go into the box, and these are fastened with brass nails to the pieces of paper to be covered (see Fig. 64). Coat it and distribute it smoothly, and hang the coated leaf in the box, which should often be turned round. The turning round should at first be done quickly, to prevent the solution running off, and afterwards more slowly when the paper is somewhat dried.

As soon as the paper is perfectly dry, remove it from the heat; too great a heat decomposes it.

Platinotype paper exposed to air soon takes up

moisture and spoils. It is therefore kept in an air-tight tin canister, in which is a division containing calcium chloride, which absorbs water.* The latter is put in the canister for the purpose of keeping the enclosed air dry. It must be renewed as soon as it becomes damp.

Freshly prepared paper always gives the best results, so too large a store should never be kept.

Printing on Platinotype.†

Take care not to touch the film side of the paper with the fingers in cutting it up. On account of the great susceptibility to moisture of platinotype paper, it is advisable, especially in wet weather, to keep a piece of oiled silk or rubber cloth behind the paper in the printing frame. The printing goes on quickly In diffused daylight print until all the details of the picture are visible in faint brown against a yellow ground. It takes some practice to arrive at the right depth for printing. Good results can only be obtained with a clear, vigorous negative. Thin or flat negatives give similar prints.

Developing, Fixing, and Washing Platinotype Prints.

Development. A cold saturated solution of oxalate of potash in distilled water is warmed to 176° or 185° F. in an enamelled iron dish. The solution must always have an acid reaction (it should turn blue litmus paper slightly red), and, if necessary, it is acidulated with a saturated solution of oxalic acid. If the acidulation is neglected yellow prints will result.

* Such little cases may be purchased.

† The placing of platinotype paper in the frame, as well as the later operations, should be done in yellow or lamplight, or *very weak* daylight.

The print is laid in the developing bath with the film side down, guarding against air-bubbles. Development instantly occurs; to leave the print longer in the solution is purposeless.

The developer may be used for a long time, till it becomes bright red. It is then saved for the recovery of the platinum contained in it.

If the prints are not developed immediately after printing they must be kept in the tin case already mentioned.

Prints of a brown colour are obtained if to every 100 parts of developer 20 parts are added of a solution of 4 grms. (62 grs.) chloride of mercury in 100 c.c. (4 ozs.) water. After a short time the developer deposits a brown precipitate, and cannot then be used to develop brown prints, but may still be used for black ones.

Fixing. To remove the iron salts the prints are laid, after development, in a dish with diluted hydrochloric acid (10 parts pure hydrochloric acid in 800 parts of water). This solution must be changed as often as it assumes a yellowish colour. It is sufficient to change it three or four times, and to let the picture lie in it for about 10 minutes each time.

Washing. After the last hydrochloric acid bath the prints are washed for 15 or 20 minutes in water several times changed, and dried over pegs.

Retouching and Mounting Platinotypes.

Retouching. Black chalk or lead pencil is used for retouching platinotypes. They can be retouched very well on account of their matt surface. Clouds can be put in very easily by means of a stump and black chalk.

Mounting.—Platinotypes are mounted as described on p. 153. It is unnecessary to damp the prints, as they never curl when spread with paste

The prints may also be given more vigour by means of *gelatine*. For this purpose a solution of the following composition is prepared:—

Gelatine	125 grms.	= 1928 grs.
Water	1000 c.c.	= 35 ozs.
Powdered alum ...	125 grms.	= 1928 grs.

The gelatine is dissolved in a bath of water, the solution heated to boiling point, and the alum added last. For use, mix 1 part of the solution with 1 or 2 parts of water.

The dry platinotypes are immersed for a few minutes in this solution. Then lay them in a dish of water for a short time and dry them.

Faults in the Hot Bath Platinotype Process.

1. *Flat prints.* Cause: (*a*) Old or damp paper; (*b*) flat negative. Remedy: (*a*) Use fresh paper, and keep calcium chloride in the case with it; (*b*) use more Solution III. in the preparation of the paper (see p. 181).

2. *The pictures become flat in drying.* Cause: The paper was dried too slowly after sensitising. Remedy: Quicker drying (10 minutes at most), or if this is no good, preparation of the paper with stronger solution of arrowroot.

3. *Vigorous but fogged prints.* Cause: (*a*) The paper has been exposed to light; (*b*) it was dried at too high a temperature; (*c*) decomposed iron solution.

4. *Hard prints.* Cause: (*a*) Too short exposure; (*b*) too much Solution III. in sensitising solution. Remedy: (*a*) longer exposure; (*b*) use less Solution III. for hard negatives.

5. *Round white marks* occur if air-bubbles cling to the paper during development, hindering the action of the developer.

6. *Stripes* are caused by uneven coating or a dirty brush.

7. *The prints turn yellow.* Cause: (*a*) alkaline developer; (*b*) insufficient treatment with hydrochloric acid; (*c*) bad washing. Remedy: (*a*) Acidulation of developer with oxalic acid; (*b*) and (*c*) are self-evident.

8. *Black points* are caused by the reduction of the platinum in consequence of particles of metal contained in the substance of the paper.

7. PLATINOTYPE WITHOUT DEVELOPMENT.

If the sensitising solution for the preparation of platinotypes be supplied with an excess of potassium or sodium oxalate (the substance which in the platinum process with development serves to produce the image), the prepared paper has the property of direct printing, so that the prints need only be fixed with hydrochloric acid (1 to 80).

*The preparation, sensitising, and drying of the paper is carried out in exactly the same way as the hot bath process.** The latter has the advantage over the direct printing process of greater sensitiveness and better blacks. But the direct process is considerably simpler.

SENSITISING SOLUTION FOR PLATINOTYPES WITHOUT DEVELOPMENT.

Sol. I.	Chloro-platinite of potassium	1 grm.	= 15 grs.
	Distilled water ...	6 c.c.	= $\frac{1}{4}$ oz.
„ II.	Soda or ammonia ferric oxalate †	40 grms.	= 617 grs.
	5% Potassium oxalate solution	100 c.c.	= 4 ozs.
	Glycerine	3 „	= 50 mins.

* Platinotype printing-out paper may be bought under the name of Pizzighelli paper, called after its inventor.

† Ammonia ferric oxalate is more sensitive than soda.

To make Solution II. warm the potassium oxalate solution to 40° or 50° C., and dissolve the ammonia or soda ferric oxalate in it. After cooling the solution must be filtered, or the sodium or ammonium oxalate will separate.

Sol. III.	Solution II.	100 parts.
	Potassium chlorate solution (1 gr. (15 grs.) potassium chlorate in 20 c.c. ($\frac{3}{4}$ oz.) of water) ...	8 „
„ IV.	5% Solution of chloride of mercury	20 „
	5% Solution potassium oxalate ...	40 „
	Glycerine	1 „

The sodic ferric oxalate is apt to go mouldy; too great a stock, therefore, should not be prepared at once.

For *black pictures* mix, shortly before use, for a sheet 17 × 22 in., using ordinary negatives:—

5 parts	Sol. I.
6 „	„ II.
2 „	„ III.

For hard negatives Solution III. should be increased, and II. correspondingly lessened; for flat negatives *vice versâ*.

For *brown pictures* mix:—

5 parts	Sol. I.
5 „	„ III.
3 „	„ IV.

Increase Solution IV. and diminish Solution III. if very brown pictures are required; *vice versâ* for blackish ones.

Printing on Platinum Paper without Development.

The paper should be taken from its calcium chloride box about half an hour before use, so that it may

absorb some moisture from the air. If it is too dry the image is not visible during printing, and must be developed by careful breathing.

Printing-out paper is considerably less sensitive than developing paper.

The printing should not be carried further than desired in the finished print, as nothing is lost during fixing.

The prints are fixed in diluted hydrochloric acid, washed, etc., in the way already described.

8. PLATINUM TONING OF SILVER PRINTS.

If prints upon albumen salted or chloride, or silver gelatine or collodion paper, are placed in a dilute solution of chloro-platinite of potash, the silver image is converted into a platinum image, with the formation of chloride of silver. The chloride of silver is removed by fixing in hypo.

Prints on salted paper* are especially fitted for turning into platinum pictures. About preparing this see p. 146.

The platinum toning process has the advantage that by its means good results can be obtained from thin negatives, which would give flat prints in other platinotype processes. The platinum toning process is also considerably superior in economy of platinum.

The operations up to the toning are exactly like those of ordinary silver prints.

Changing the Prints into Platinotypes.

The much over-printed pictures should be *very carefully* soaked (see p. 149), and then put in the following bath, which keeps, and can be used again and again.

* A silvered salted paper that will keep and give good results has been specially introduced for this purpose under the name "Silver Platinotype Paper."

PLATINUM TONING BATH.

Chloro-platinite of potassium	1 grm.	= 15 grs.
Distilled water	500 cc.	= 17 ozs.
Nitric acid	10 „	= $\frac{1}{4}$ „

In this bath the prints are left until, looking *through* them, they appear a greyish black colour.* They are then rinsed out, fixed for 10 minutes in a 10% solution of hypo., well washed and dried. *If the pictures tone too slowly they were not sufficiently washed.*

9. USE OF RESIDUES OF POSITIVE PROCESSES.

As in negative processes, only a small part of the silver, gold and platinum salts used in preparing the paper for printing is actually used in forming the image; by far the greatest part of it goes away during development and fixing, and can easily be recovered.

The following solutions or scraps of paper should be saved for the recovery of the gold, silver or platinum in them :—

1. The first washing water of albumen salted and chloride of silver gelatine and aluminium prints (see p. 149).

2. The gold baths, with the exception of the sulpho-cyanide of gold baths. †

3. Fixing baths of all silver printing processes.

4. *Unfixed* scraps of silver paper.

These residues are made use of in the following manner :—

1. The washing water is treated with hydro chloric acid until a precipitate (chloride of silver) is formed. To obtain the latter pour off the solution, wash the precipitate several times on a filter, and dry it.

* Prints which have not been sufficiently toned assume a reddish brown colour in fixing.

† The gold is difficult to recover from sulpho-cyanide.

2. The gold baths should be acidulated with hydrochloric acid, and mixed with a solution of sulphate of iron which separates the gold, which is then filtered and washed.

3. The fixing baths should be treated as those of negative processes (see p. 142).

4. Scraps of paper should be burnt, and the ashes which contain silver collected.

The following residues of *platinum processes* should be collected: (1) the old developer; (2) pieces of paper.

Their treatment is as follows:—

1. Add to the developing solution $\frac{1}{5}$ of its volume of saturated sulphate of iron solution; heat to boiling point in a porcelain dish.

The platinum is deposited as a black powder, which should be filtered off and washed.

2. Pieces of paper should be burned, and the ashes, which contain platinum, preserved.

What is thus obtained is best handed over to a chemical factory for further treatment.

VI.

COPYING PROCESSES.

The processes described below enable us to multiply copies of drawings, books, etc., without a negative.

The drawing to be copied is simply placed in a printing frame, with a piece of sensitive paper pressed against it, and exposed to light. Thus a copy the exact size of the original is obtained.

There is a distinction between *negative copying processes*, that is, those which produce a negative copy of the writing or drawing (like the ferro-prussiate process), and *positive copying processes*, in which a positive is obtained at once (ink process, aniline printing).

Only the most important easily performed processes are given here.

The paper used to make copying paper should be moderately thick, such as Saxe, upon which the sensitising solution is spread as in the platinum process (see p. 181). The brush must be carefully cleaned immediately after use.

The drying of the paper after sensitising takes place at an ordinary temperature.

1. THE FERRO-PRUSSIATE PROCESS.

The ferro-prussiate process is the simplest and most used of all copying processes.

By its means *negative copies* of the picture to be multiplied are obtained. Ferro-prussiate paper can be bought ready for use, and keeps a long time.

The paper may be easily and safely prepared at home according to the following directions :—

SENSITISING SOLUTION.

Sol. I.	Distilled water ...	50 c.c.	=	1½ oz.
	Ferri-cyanide of potassium	8 grms.	=	123 grs.
„ II.	Distilled water ...	50 c.c.	=	1½ oz.
	Ammonia-citrate of iron	10 grms.	=	154 grs.

The solutions, when made up, will keep, but should not be exposed to the light.

For use, mix equal parts of Solution I. and II., and filter.

The preparation of the paper takes place by subdued daylight or bright lamplight. The paper has a yellowish green colour when dried, and if dry keeps a long time. In light it turns dark blue.

It is printed under a drawing, in direct sunlight if possible, until the finest lines show blue. The print is then washed until it no longer colours the water, and then dried.

Old paper prints a peculiar green, and turns blue in washing; it is difficult to tell when such paper has been exposed long enough.

If a brighter blue is desired, lay the print after washing in diluted hydrochloric acid (1 to 50). It must be well washed again after the hydrochloric acid bath.

Corrections may be made on the dry print by means of a solution of 2 grms. (31 grs.) oxalate of potassium in 50 c.c. (1½ oz.) of water. One can write on the blue ground of the print with this solution as with ink; the writing immediately appears white.

2. THE INK PROCESS.

The ink process gives positive prints of a positive drawing. The preparation of the paper is not so easy

as in the ferro-prussiate process, because it is more difficult to spread the sensitizing solution evenly over the paper.

SENSITISING SOLUTION.

Sol. I.	Ferrous sulphate	... 10 grms.	= 154 grs.
	Tartaric acid ...	... 10 „	= 154 „
	Ferric chloride	... 20 „	= 308 „
	Distilled water	... 200 c.c.	= 7 ozs.
„ II.	Gelatine ...	... 10 grms.	= 154 grs.
	Distilled water	... 100 c.c.*	= 4 ozs.

For use, mix Solutions I. and II., and while still warm filter them through flannel. Solution I. keeps a long time in the dark.

The paper should be prepared by lamp or faint daylight. It should be dried in darkness.

The prepared paper † is best used quickly.

It is exposed under a drawing (direct sunlight is best) until the black lines of the drawing are faintly visible as yellow on a perfectly white ground.

Put the exposed paper for three minutes in the following

DEVELOPER.

Gallic acid	7 grms.	= 108 grs.
Oxalic acid	1 „	= 15 „
Water	... 1000 c.c.	= 35 ozs.

The yellow lines become a deep black during development by formation of ink.

If it was under-exposed the ground of the picture is coloured also; if over-exposed, the finer lines disappear.

After development is finished, rinse the print well,

* The water should be warmed, and the gelatine placed in it

† It can be obtained commercially.

remove the surplus water * with blotting-paper, and dry.

3. ANILINE PRINTING.

Aniline printing is most to be recommended of the copying processes, as it gives good results after less experience.

The aniline process is greatly superior to the foregoing ones in sensitiveness; by its means a positive copy of a drawing is obtained.

The paper keeps only a short time (one day), and is therefore not on sale. It is prepared according to the following directions, and is exceedingly simple. Aniline prints are absolutely permanent.

SENSITISING SOLUTION.

Bichromate of potash	... 10 grms.	=	154 grs.
Solution of phosphoric acid (sp. gr. 1·124)	... 100 c.c.	=	5 ozs.
Distilled water ...	... 100 „	=	„

The solution will keep for an unlimited time, but the paper prepared from it only a short time (one, or at most, two days).

The preparation of paper is carried on by lamp or subdued daylight; it should be dried in the dark.

It is printed under a drawing till the black lines of the drawing appear faint yellow on the greenish-white ground.

The prints are then put into the fuming box, that is, a large card, tin, or wooden box. On the inside of the lid of the box is fastened a piece of flannel, moistened with water, and another piece upon which a small quantity of the following aniline solution is poured.†

* If this is omitted the lines of the drawing are apt to disappear.

† One application is enough for several days.

Neither solution must drip on the print, or yellow spots will appear.

ANILINE SOLUTION.

Aniline	10 parts.
Benzine	160 „

After 5 or 10 minutes the yellow lines will take a dark blue-green colour; the print is then washed for a short time and dried.

By bathing the print in diluted ammonia the dark green lines will become violet.

The colour of the background also changes in fuming if the prints are under-exposed; if over-exposed, the fine lines of the drawing will be invisible. Moisture is absolutely necessary in developing aniline prints; the piece of flannel attached to the lid of the box must therefore always be wetted before fuming. If the air in the box is too dry the image will generally not develop.

Instead of the formula given above, the following one (by Weissenburger) may be used for the preparation of the paper:—

Bichromate of potash ...	3 grms. =	47 grs.
Acid phosphate of soda ...	8 „ =	123 „
Magnesium chloride ...	3 „ =	47 „
Distilled water	40 c.c. =	1¼ oz.

APPENDIX.

Amidol Developer.

Amidol has quite recently been introduced as a developer for bromide of silver gelatine plate. It has the great advantage over other developers that it works vigorously without the addition of an alkali (carbonate of soda or potash), which is apt to act strongly on the gelatine film, and cause "frilling."

The development proceeds quickly, and the negatives easily attain the desired vigour. The developer is suitable for time-exposures, and also for instantaneous work.

Amidol is also particularly suited to the development of bromide paper; for this purpose it may be diluted with four times its volume of water. The composition of the developing solution is as follows:—

Crystallised sulphite of soda	50 grms.	=	771 grs.
Amidol	5 „	=	77 „
Distilled water	1000 c.c.	=	35 ozs.

The addition of a few drops of 10 % solution of potassium bromide is advisable with this developer. The solution may be repeatedly used, and colours very gradually.

A Means of avoiding Halation.

In architectural work it is often impossible to avoid photographing opposite a window. The contour of the

window is then surrounded by a more or less evident halo in consequence of the reflection from the back of the plate. To avoid this (says Cornu) the back of the plate is spread with the help of a pad of wadding, with a mixture of 6 parts clove oil, with one part turpentine, made into a paste with soot. Before development this backing must be completely removed with smooth paper or wadding.

Reduction of Over-printed Silver Prints.

Over-printed silver prints (albumen-salted chloride of silver gelatine and collodion and bromide prints) may be reduced by means of the ferri-cyanide of potassium reducer described on p. 93, which is, for this purpose, diluted with two volumes of water.

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